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MECHANICAL ENGINEERING

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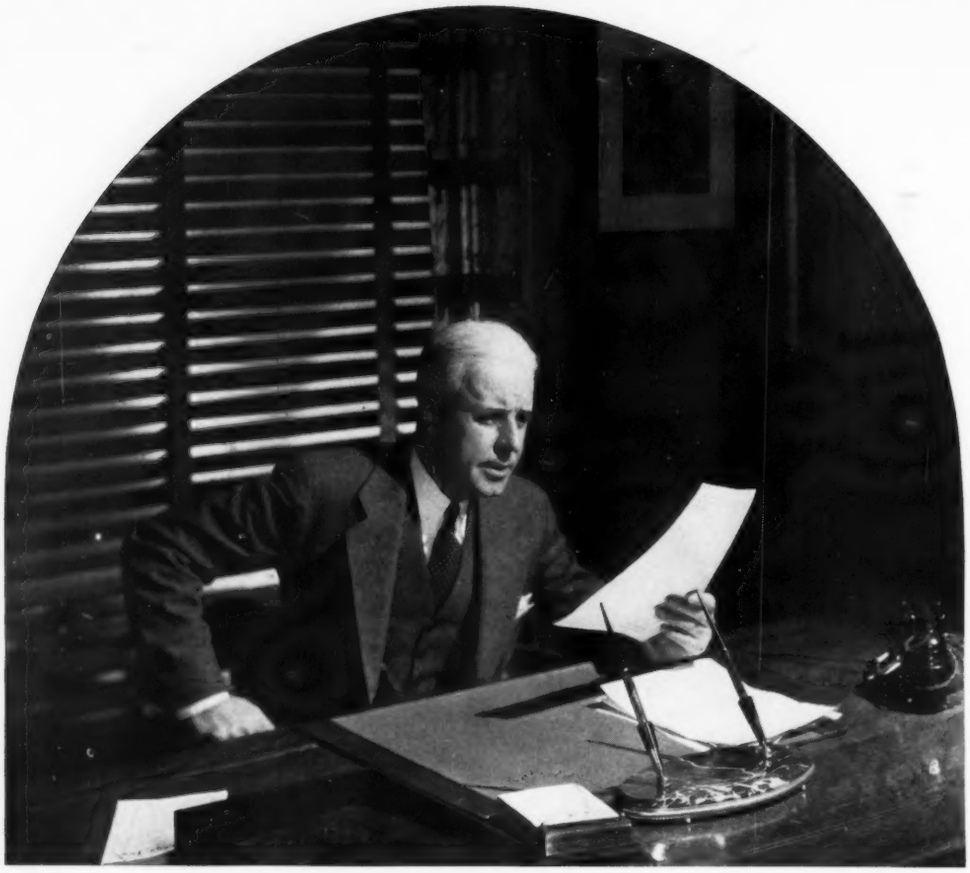

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MECHANICAL ENGINEERING

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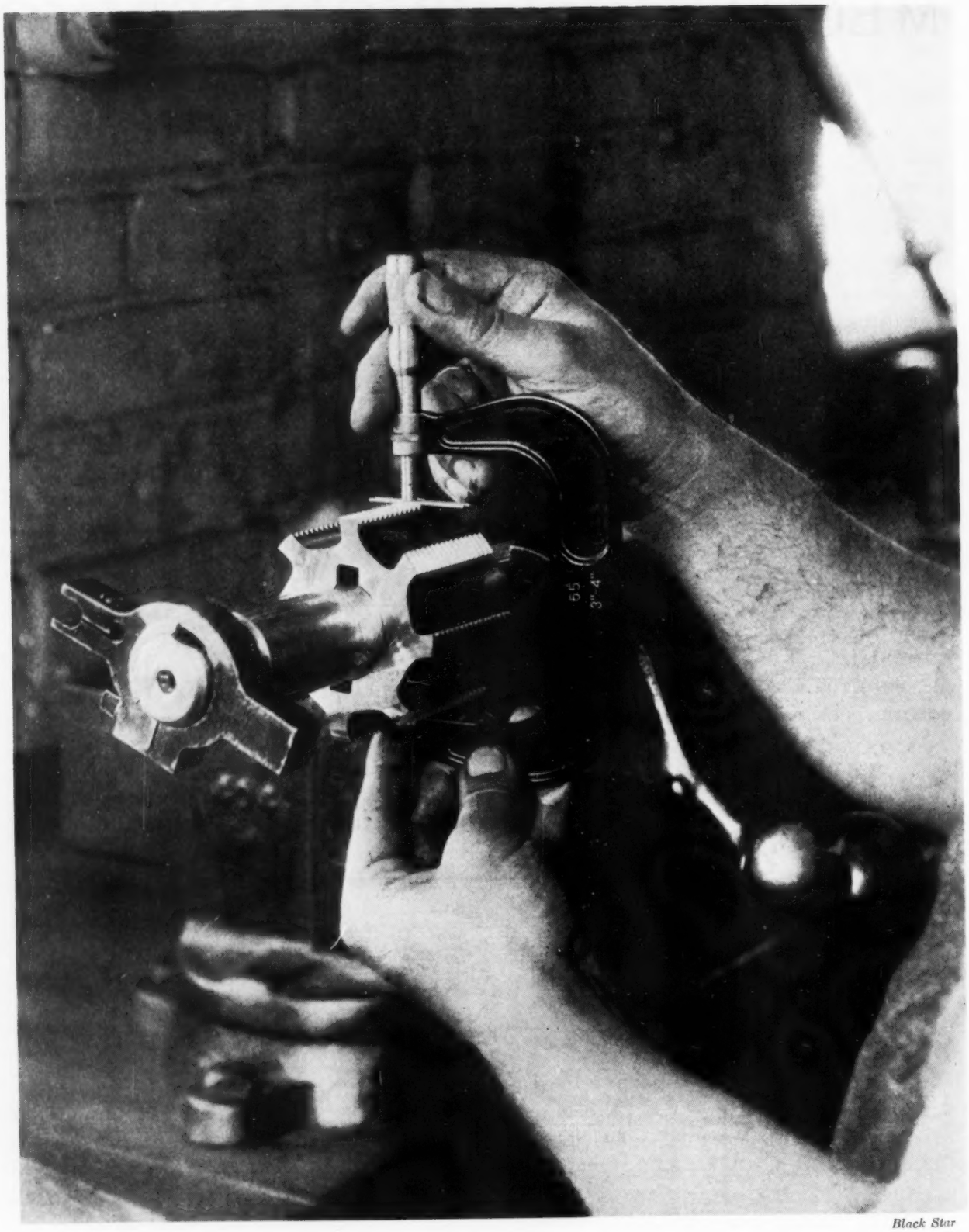

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Precision Based on Skill

VOLUME 63
No. 8

MECHANICAL ENGINEERING

AUGUST
1941

GEORGE A. STETSON, *Editor*

Professor Sweet's Idea

ANNOUNCEMENT of the appointment of Prof. Frank O. Ellenwood, head of the department of heat-power engineering at Cornell and member A.S.M.E., to the John Edson Sweet memorial professorship at that institution, evokes many trains of thought.

There are engineers who came under Professor Sweet's influence at Cornell who will run back over the years to their youth and to recollections of the man for whom the professorship is named. Graduates of more recent years will be glad to know that the professorship, first held by the late Herman Diederichs, has so worthy an incumbent. Members of The American Society of Mechanical Engineers will recall that it was Sweet who, in 1880, summoned the first conference at which the formation of a mechanical-engineering society was discussed and who, in 1884, served as the third president of the Society thus formed—one of the three "honorary members in perpetuity."

But the name of Sweet also brings to mind the Straight Line Engine Company, at Syracuse, N. Y., headed by the professor, and the words cut in the stone arch above the doorway of the plant, "Visitors Always Welcome." Sweet was one of the pioneers in breaking down the traditional attitude of secrecy that closed many shops not only to the general public but to other engineers and manufacturers. Unfortunate experiences made manufacturers wary not only of their rivals but also of persons who did not have the appearance of being rivals. One recalls the celebrated controversy over the steam hammer, for example. But Sweet and men like him did not hold with the philosophy of extreme secrecy. As many of them have said, "Let my competitors see what I am doing. Before they can get my methods put to use, I'll have something much better." And there was always a chance that, as Benjamin Lamme explained in defense of his habit of making his office easy of access to young men, "I might shut out more than I shut in."

Free interchange of ideas among engineers was one of the motivating objectives of The American Society of Mechanical Engineers, of which Professor Sweet was a founder. It remains today a powerful force among many which the Society exerts. Engineers have learned the lesson Professor Sweet taught them and have realized the benefits that come from the mutual exchange of ideas and hard-won knowledge. Businessmen have found that it pays to invite the public to come into their plants. Manufacturers of automobiles and processors of foods maintain factory guide services for thousands of customer-visitors. Engineers exercise a cordiality and frankness in the discussion of each other's problems that stimulates giver and receiver alike.

Recent events have forced even wider acceptance of Professor Sweet's fundamental idea. Subcontracting under the National Defense Program is breaking down some of the few remaining barriers of secrecy that remain. A large and progressive concern, which in all departments from fundamental research to the assembly lines has developed special tools, methods, and manufacturing experience, finds today that it must share its knowledge with other concerns, sometimes its natural competitors, if its subcontracts are to be properly and quickly executed. In some cases minutest details are released, not only to one but possibly to dozens of subcontractors, and special organizations are set up by the prime contractor, as pointed out in recently published papers in this journal, to facilitate the execution of these subcontracts.

Thus Professor Sweet's idea comes to full fruit, and engineers find themselves in an era when common danger makes it necessary for them to have common and complete knowledge. The opportunity that engineering societies have of assisting in this broader dissemination of knowledge, by means of meetings and publications, is unique and should be exploited to the fullest extent. The spirit of John Edson Sweet was never more vital in engineering than it is today.

National Roster

LATE in June representatives of the engineering societies and other groups of scientists and engineers met with representatives of the National Roster of Scientific and Specialized Personnel at the National Academy of Sciences in Washington to listen to a recapitulation of the accomplishments of the Roster and to discuss further developments.

Members of The American Society of Mechanical Engineers will recall that during the winter they received from the Roster a questionnaire and a check list, which, when filled out and returned to Washington, permitted the Roster to place the information thus provided on punch cards so that names of specialists, in whatever field a need for personnel developed, could be made available to government agencies at almost a moment's notice.

Government agencies are required by law to recruit personnel from civil-service lists. In the present emergency, as is well known, civil-service lists are either exhausted or do not cover the specialists demanded by the emergency. Filling this gap is the Roster. It was

gratifying to learn, first, that about 50 per cent of the questionnaires had been returned and were well along toward codification, and second, that at least 30,000 names had already been provided to several government agencies at their request.

What the Roster is and how it works was explained on page 701 of the October, 1940, issue of MECHANICAL ENGINEERING. A more detailed and popular explanation will be found in an article in *Harpers* for July, "Dr. Scott Goes to Washington." The Roster staff has behind it the full knowledge of the experience of the Central Register of Great Britain where conditions have been so acute that in certain categories (particularly engineering) registration has been made compulsory. In this country, registration with the Roster is still on a voluntary basis. The information on file is confidential and available to government agencies only. Proposals to increase the coverage afforded by the Roster, still on a voluntary basis, have been made. It appears to be a patriotic service for engineers to file their names and professional experience with the Roster, and events of the future may intensify the need the government has of the information on personnel the Roster provides. Just as registration with the Roster is voluntary, so also it rests entirely with an engineer's conscience and sense of duty to his country and his personal interests to accept whatever call for service may come as a result of his enrollment with this group of specialists.

Wanted: Physicists

ONE of the critical needs of nations at war, as experience all over the world has proved, is for physicists. This group of highly talented and educated men is all too small for the demands made upon it. Of all the groups registered with the National Roster of Scientific and Specialized Personnel, this one is being most thoroughly combed. To the credit of the physicists let it be said that they have made available in Washington for the assistance of the Roster staff the services of Dr. Henry A. Barton, director of the American Institute of Physics, whose knowledge of the nature of the work to be done and of the men most competent to perform it is proving a valuable asset.

Just what constitutes a physicist it would be useless to define precisely. Obviously, the term is broad enough to cover a reasonable number of men who think of themselves as engineers, and perhaps a fair proportion of the more active members of the Applied Mechanics Division of The American Society of Mechanical Engineers. Indeed, it is known that many members of the division are actively engaged in this field of national defense, and the Society takes pride in their service. The situation emphasizes the importance of the division and the wisdom of the Society in encouraging its activities and gives rise to a few thoughts on which engineers may well ponder.

That field which lies betwixt the physical sciences and engineering is the one which the A.S.M.E. Applied Mechanics Division serves. No one can glance over the rich literature of the division without being impressed with the service that is being rendered on the outposts of engineering by this group. Yesterday's science is today's field of engineering research and tomorrow's field of engineering practice. The fact is too obvious—can be proved by too many examples—to need elaboration. And because of this the activities of the division constitute, from one point of view, the greatest resource for national service that the Society has. Today the special talents and knowledge these men possess are urgently needed for military purposes. The competition of nations at war is keen and must be met instantly—nay, it must be anticipated, in a technological society, if a nation is to survive. Tomorrow, and in the years of reconstruction of peaceful society which must inevitably come, these talents and this knowledge will be in even greater demand. Without forgetting or minimizing the importance of other activities—statesmanship, the social and political sciences, administration, construction, and production—this field of the A.S.M.E. Applied Mechanics Division will be a vitally important one for the world, for the nation, and for the A.S.M.E. And so, without neglecting the constructive arts of modern production methods, power generation, and industrial management which the A.S.M.E. has traditionally served, it should seize the opportunity to develop to the fullest extent this other area of research, design, and development in which the physical sciences are transformed into sound engineering practice.

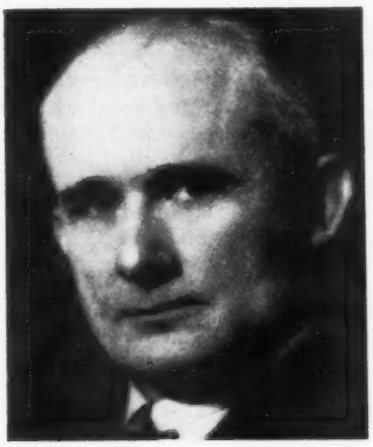
The Society's opportunity and responsibility go deep into the roots of engineering education and extend far into the branches of engineering practice. No more shortsighted national policy could be adopted than that of limiting the number of men being trained for the work of physicists in engineering and industry or of reducing the length or content of curricula in which such men are trained. Through its own agencies and those it shares with other groups, the Society must take a firm stand on this point and offer help and encouragement to institutions and men engaged in the educational effort. Second, it must strengthen the work of its student branches to create an atmosphere of understanding and encouragement for its student members who are destined to enter this field. Third, it must afford a real intellectual home for young graduates during the years in which they are being inducted into the professional work of these careers. Fourth, it must continue to afford, in meetings and publications, opportunities for these men to exchange their ideas, knowledge, and experience. Fifth, it must recognize and publicize the services these men render, increasing the understanding and appreciation employers, engineers, and the public have of these services. And sixth, it must bridge the gap which too frequently exists between these men and those whose talents in construction and production make possible the richest and earliest benefits to the world at large which will spring from the pioneering work done by men who are active in this field.

The American Society of Mechanical Engineers must continue to develop its functions as a catalyst, as a coordinator, and as an organizer of new ideas. Otherwise it will neglect its greatest opportunity and forfeit its birthright.

Our Unused Potentialities for AERONAUTICAL RESEARCH *and* DEVELOPMENT

By JOHN E. YOUNGER

PROFESSOR AND CHAIRMAN OF MECHANICAL ENGINEERING, UNIVERSITY OF MARYLAND



THE Spirit of St. Louis Gold Medal Award may well be considered the highest aviation honor possible of attainment by an individual. This is true for several reasons: Because it is contributed, not by an individual, but by a large group of public-spirited citizens of one of the nation's most air-minded cities; because its presentation is not limited in an engineering group, but gives equal consideration to all, whatever his profession, or whatever his contribution may be; and last but not least, because of the distinction given the award by its former recipients, Guggenheim, Litchfield, Rogers, and Doolittle.

As the selection of the recipients of the Spirit of St. Louis Gold Medal well indicates, there are many phases to the development of aviation, each of great importance and necessary for a sound growth. As the development progresses, the phases become more numerous and complex, and require greater and greater originality, technical training, and skill.

We, who in the early days of aviation cast our lot in its development, felt, even at that early date, as we feel today, that aviation is destined to be the greatest industry that the world has ever seen. The industry of transportation in the air is certain, in time, to dwarf the industry of transportation on land and the industry of transportation on the water. Attention is called to these predictions because the fact should be emphasized that aviation is in its very early stages of development, and that programs of development, which are initiated now, will be contributing to the aeronautical sciences for generations to come.

LACK OF FUNDS FOR TRAINING AERONAUTICAL ENGINEERS

In studying our development programs, we note that there is one serious deficiency in its provisions which will make it increasingly difficult to retain our leadership in aviation.

Aviation being a first-line national-defense project, Federal funds have been provided for the construction and operation of great laboratories for developing the fundamental principles on which our future aviation progress will be based. Federal funds have been provided for the training of thousands of pilots to fly the airplanes which are developed. Federal funds have been provided for the training of thousands of mechanics, draftsmen, and other craftsmen for the construction and maintenance of our airplanes of the future. In fact, funds have been provided for practically every phase of aviation except the most important phase of all, i.e., the training of engineers whose business it will be to design and superintend the construction of those marvels of mechanism, the airplanes of the future, and to make those airplanes better than they can be made anywhere else in the world.

How are these engineers trained at present? In general, excepting the few Guggenheim Schools of Aeronautics, they are trained by funds provided by the states at state universities. In brief, the Federal Government provides funds for the development of aviation (which is certainly a Federal project, being absolutely essential to our national defense and security) in all phases except the most important one, and in this one phase it is left for the state governments to provide the funds.

In this engineering-training phase, however, the state is not primarily interested in the development of aviation, but rather in the education of its sons and daughters to a certain level of attainment. Obviously, states cannot afford to give preference to aeronautical training over other courses provided in the schools of the state. The state government cannot be expected to provide the funds for the extensive laboratory facilities, and the endowments of chairs for teacher-research professors, all necessary to provide adequately the essential scientific engineering training. Funds necessary for such a single endowment would range from $300,000 to $600,000. It is not within the province of the state to provide these funds which are over and above those for the standard 4-year training. If additional educational training, for the aeronautical engineers who are to be the designers of the future air liners, is to be provided for, and certainly this will be absolutely necessary, funds must come from some other source, i.e., personal endowment, endowment by the industry, or endowment by the National Government.

The aviation industry loses in two ways because of this gap in our aeronautical educational and development program. It fails to acquire highly developed technical personnel with adequate training and vision for original developments, and it also loses a highly efficient and original source of research for the germination of new ideas, methods, and principles.

Daniel Guggenheim temporarily alleviated this difficulty 15 years ago when he endowed the Guggenheim Schools of Aeronautics. We are now reaping the maximum benefit from

Presented, upon award of the Spirit of St. Louis Gold Medal, at the banquet held in conjunction with the Semi-Annual Meeting, Kansas City, Mo., June 16–19, 1941, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

this investment. When these schools were established, however, aeronautics was mostly aerodynamics. These schools were, therefore, centered about large aerodynamical laboratories which, at that time, were among the best in the world. To these schools we may attribute largely the fact that, of all the phases of aviation, the science of aerodynamics is the most highly developed. In general, aerodynamicists are not now accepted in the industry, unless they have had two or three years of postgraduate training.

Other aeronautical sciences are so far behind the science of aerodynamics in development that practical use cannot be made of the new discoveries in aerodynamics. By all means the development of aerodynamics must not be slowed down, but other phases of the aeronautical sciences, of equal importance, should be given equal consideration for a balanced program. The standard of aeronautical training and research in structures, materials, fabrications, and other phases of aeronautics must be brought up at least to the standard set for aerodynamics.

When we predict that great air liners will ply the upper regions of the stratosphere at incredible speeds, with great comfort and absolute safety, we are not making a broad guess. We know that this is certainly something we shall see in our own generation. While we feel certain that such developments as these will occur, we do not claim that these extremes will be obtained by virtue of our present materials, or present types of engines, our present types of propellers, our present types of structures, or our present knowledge of aerodynamics, aviation psychology, and aviation medicine.

There, of course, will be progress in all these phases of which, on the basis of our present knowledge, we cannot now conceive. Today, in one of our schools, there may be a young scientist, just growing into maturity, who will someday revolutionize our present conception of the aircraft engine and, like young Otto, or Diesel, open new possibilities for power development. Possibly, in our schools, there is another young scientist who may someday show us how to combine metals to produce materials which will far surpass anything that the world now considers possible. Undoubtedly, new methods for cheaper production of known materials will be discovered. New ideas of fabrication, at present beyond our comprehension, will certainly make current methods appear as crude as those of 20 years ago appear to us now.

FUTURE AERONAUTICAL ENGINEERS NEED SUPPORT NOW

We naturally think in terms of ideas which have been germinated and then cultivated by intensive research until they have grown into our everyday life. Nearly all our national research in aeronautics goes into the development of known principles, and methods. No special attention is given to the germination of new ideas. It is this phase of research which thrives so successfully in our university research laboratories. When the young scientists, who are now developing in our schools, reach maturity and complete their undergraduate work in some university, we are neglecting an opportunity to use their latent potentialities in our aeronautical research and development, if a continuation of their education is not adequately provided for, and laboratories are not available for their training and for stimulating their ideas.

The germination of new methods, ideas, and principles very often originates with young people in the course of their research required for graduation from a university or for higher scholastic degrees. These young people have more imagination than older ones who are limited by their experiences. They, not knowing that a thing cannot be done, go ahead and do it. The seeds of many of their new ideas, methods, and principles in aviation do not now grow because of lack of cultivation. When these young people graduate or receive higher degrees, it then becomes necessary for them to leave the research in which they are interested to make a living for themselves. If they obtain employment in research establishments, their positions will be in a subordinate capacity, so that their full time must be spent in developing ideas, principles, and methods promulgated by higher authorities on the basis of immediate necessity.

It is extremely rare that the young scientist can find employment in research similar to that which he had pursued in his academic training. If funds and laboratory equipment were available in universities so that these young scientists, who show great promise in originating new ideas and in carrying out the research thereon, were available so that they could continue this development on a moderate salary until it were completed, the aviation industry would be more richly rewarded in progress, dollar for dollar, than it receives from any other research source.

In universities where association with these young engineers and scientists stimulates imagination and thought in research, the constant scrutiny and review of fundamental principles, and discussion prompted by those who are thinking along these lines for the first time, provide an unsurpassed background for the germination of new ideas.

In the fields of physics, chemistry, and life sciences, these facts are recognized and provisions are made for utilizing these assets by substantial endowments from public-spirited citizens, contributions from the allied industries, and from the state and national governments. In the aeronautical sciences, except for the one great contribution of Guggenheim, there has been slight encouragement from private sources, the industry, or the government.

BRANCHES OF AERONAUTICAL SCIENCE WHICH SHOULD BE ENDOWED

Now is an opportune time for public-spirited philanthropists to continue the excellent work started by Daniel Guggenheim by endowing aeronautical-research laboratories in fields other than aerodynamics, such as structures, radio, medicine, psychology, and particularly in the field of high-altitude flying in hermetically sealed pressure cabins. This field has recently been opened, but the progress which has been made scarcely scratches the surface. Years and years of research in the many phases of this development are in the offing. The high-altitude pressure-cabin field is new for structural engineers, engine builders, aerodynamicists, metallurgists, psychologists, medical men, radio men, and many others. The field is extremely important because air travel and aerial combat of the future will be in the stratosphere. If these endowments are not forthcoming from private funds, or from the industry, it is hoped that a drive will be organized for obtaining Federal funds for filling this gap in our aviation-development program. Something must be done about the deficiency if we are to reap the maximum benefit from the millions of dollars now being spent on aviation development. An investment of 0.1 per cent in this remaining phase of aviation development would enhance the value of the programs now in progress to an extent far in excess of the additional cost incurred.

Always remember that a high standard of airplane design can never be higher than the standard of its designing engineers. Our aeronautical engineers of the present generation are good, but the engineers of the next generation must be much better. The engineers of the next generation are now students. According to the present trend, the next generation of engineers in this country will have less opportunity to develop than the present generation had. It is hoped, for the sake of our superiority in the air, we do not assume that the training which was good enough for us will be good enough for our successors

Designing SAFETY *Into* PUNCH-PRESS OPERATION

By WENDELL M. NELSON

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

EACH step of every operation in modern industry must be carefully planned, and executed according to plan, if it is to be performed in an effective and efficient manner. By the same token, the safety hazards inherent in industrial operations must be carefully studied, and the resultant safety measures rigidly adhered to, if these operations are to be performed in a safe manner.

Power presses and their tools may well be considered the most hazardous group of industrial machines, and their operation the most fertile field for accident-prevention work.

In general, there are four specific steps to be considered when planning a complete punch-press operation, and in each step safety should receive careful consideration. These steps are:

1 Selection of power press.
2 Determination and design of type of die.
3 Selection of a standard guard, design of a special guard for the particular job, or other provisions for protecting the operator.
4 Adoption of safety regulations.

SELECTION OF POWER PRESS, AND DETERMINATION AND DESIGN OF TYPE OF DIE

The first two steps must generally be planned together for a particular job, since the necessary die height, length of press stroke, and required tonnage would limit the press size. Inversely, the shape and size of the punching involved may require the use of a much larger press than the required die tonnage would indicate. In the event that the proper press is not available, it may be necessary to compromise somewhat and reach a "happy medium" between the die design and the most suitable press on hand. Due to the many types of work being required on a limited variety of presses, the safety factor frequently is not given the consideration it merits. In no case should the press ever be required to do more than it was designed to do. Tables are readily obtainable which indicate the pressures required for shearing, bending, drawing, and squeezing metals, and contain information regarding their application to the job at hand.

The punch-press crankshaft is subjected to tremendous strain in operation and it is suggested that, each time the shaft is removed for any reason, a magnetic test be given it to detect possible cracks. One large company recently tested a group of 43 crankshafts, finding that 14 of them were cracked and required replacement. The magnetic test, Fig. 1, consists of magnetizing the shaft, making the direction of the flux longitudinal so that it will intercept any possible cracks at right angles. While magnetized, the shaft is sprayed with kerosene which has in suspension finely divided particles of magnetic iron oxide (Fe_3O_4). Any cracks or discontinuities in the metal will set up magnetic poles, which, while very slight, are strong enough to attract and hold the iron-oxide particles, thereby outlining the crack which may be ordinarily invisible to the naked eye.

In the selection of a power press for any type of operation, we should first make sure that the moving parts, other than in the so-called danger zone, are properly guarded. Special attention should be given to the guarding of flywheels and foot treadles; the latter should be guarded so that they cannot be struck and tripped by fallen material. It is best to incorporate in the clutch mechanism the "single-stroke" feature. To do this the trip rod should be so arranged that, to trip the press, the pedal must be raised to the upper limit each time before depressing. This can be done very easily by a dog on the rod which engages the opposite dog on the piece connected to the tripping mechanism. As the ram descends, the dogs are disengaged and the rod connected to the treadle has to rise to re-engage the dog.

In general, press operations will fall into two groups:

1 Primary operations, i.e., blanks or completed punchings made from raw material handled in sheet, strip, or coil form.

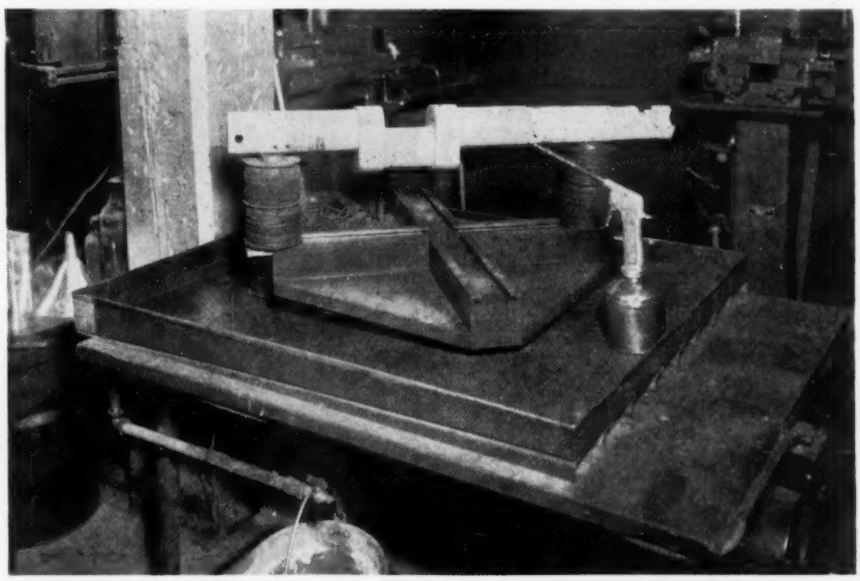


FIG. 1 SHAFT OF A PUNCH PRESS IS HERE SHOWN SET UP FOR A MAGNETIC TEST FOR DETECTION OF FATIGUE CRACKS

Contributed by the Process Industries Division and presented at the Annual Meeting, New York, N. Y., December 2–6, 1940, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

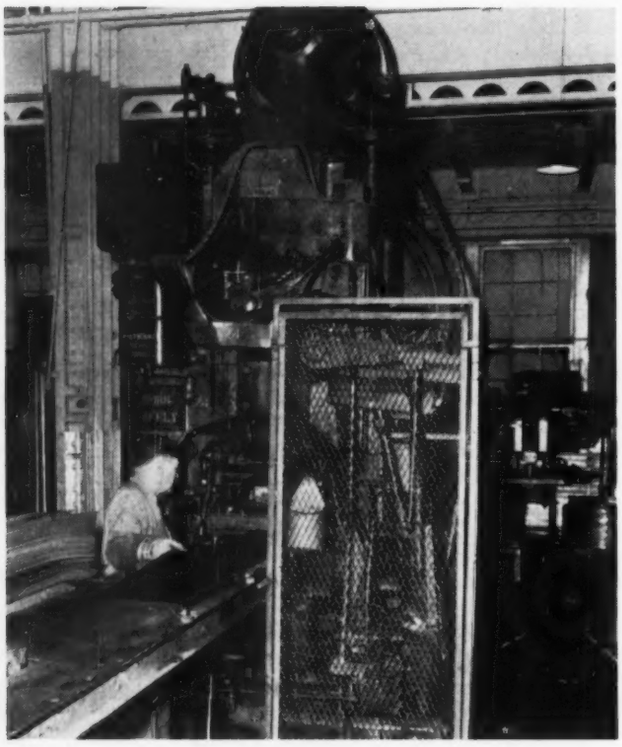


FIG. 2 PUNCH PRESS "BOXED IN" FOR AUTOMATIC OPERATION
(It is never necessary for the operator's hands to enter the danger zone with this type of guard, as the stock is fed into the press by mechanical means, such as by friction rolls or a reciprocating grip feed.)

2 Secondary operation, i.e., additional operations on precut or preformed blanks or punchings.

Where the quantity of production is great enough to warrant the expense, dies capable of producing the part as a primary operation are preferable. Since this is not always practical, however, the dies should be so designed as to combine as many stages or "operations" in each die as possible. In any case, it is usually possible and certainly preferable to design the safety features into the die itself in the case of high production. These safety features should take the form of "boxing in" the danger zone effectively, Fig. 2.

It should be remembered that all dies are inherently dangerous. In order to perform the intended operation, two pieces of metal must come together with tremendous pressures. This coming together must occur regardless of the design or the safety features incorporated into the die. The area where this occurs is the danger zone, and must be guarded, since it cannot be eliminated.

Several things can be done in the die design to aid in the safe operation of the press:

"Cut-Away" Stripper. In the case of compound-type dies, wherein the punch is set in the lower half of the die, the cut-away stripper, Fig. 3, allows the scrap material to be gripped and pulled through more easily without requiring the hands to come too close to the danger zone. This is done by actually cutting away the front of the stripper to a point as close as possible to the cutting edge.

Proper Guarding of Guide, or Leader Pins. In the event that the guide pins leave the bushings on the upstroke of the press ram, it is possible for the operator to place his hand between the top of the pin and the bottom of the bushing. When it is impractical so to arrange the pins that they will not leave the bushings, then they should be guarded by a telescoping cover.

Proper Guarding of Spring Strippers and Spring Pads. Strippers and pads of this nature should be effectively enclosed in order to prevent dirt, punchings, and even the operator's fingers from getting under them and being squeezed.

Stud-Type Spring-Pad Assemblies on Form Dies. Studs used on spring assemblies, mounted under the die shoes, should be of ample size and securely locked to the die shoe. Should this stud break, or become loosened from the die shoe, while the spring is under compression, it would fly down with sufficient force to cause injury.

After these items have been given their proper consideration, the type of feed and means of ejecting finished pieces must be decided. Feeds can be grouped into three classifications, i.e., automatic, semiautomatic, and hand.

Of these, the automatic feeds are the safest and most economical, so high-production jobs are planned to come within this group wherever possible. The semiautomatic-feed group rates next, both from safety and economic viewpoints, while hand feeds are the most dangerous and the least economical.

Automatic Feeds. Examples of automatic feeds are operations where stock is fed into the press by some mechanical means, such as, friction rolls or a reciprocating grip feed.

Semiautomatic Feeds. The greatest variety of feeds fall into the group of semiautomatics, which includes all feeding performed manually, wherein it is never necessary for the operator's hands to enter the danger zone, which can therefore be "boxed in." The following are most commonly used:

1 Semiautomatic hand feed consists of the manual operation of pushing strip or roll stock into the die from a position outside the danger zone. An "automatic finger" is incorporated in the die to position the material for each press stroke.

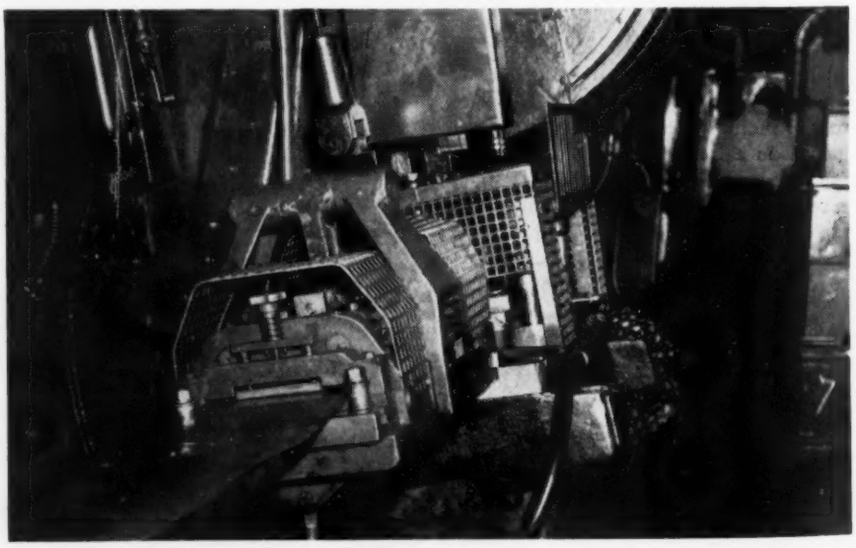


FIG. 3 THE STRIP FEED ALLOWS THE MATERIAL TO BE GRIPPED AND PULLED UNDER THE ENCLOSED DIE
(Strippers are enclosed in order to prevent the operator's fingers from being caught and squeezed in them.)

2 Vacuum feed consists of vacuum cups, mounted on a manually controlled slide arm, or handle, which pick up a sheet of material and place it in position on the die. This type is extensively used in such applications as handling large light sheets of material.

3 Gravity feeds are the most economical type of semiautomatic feeds for press work which can be made. It is probably a fact that many dies in use today could be equipped very easily with a variation of this type. Gravity feed consists essentially of an inclined chute with guides for the piece to be worked upon. The piece slides down to the positioning place and usually stops on a locating nest.

4 Push feed is somewhat similar to the gravity feed, except that the chute is kept filled and work is moved into the working area by pushing new work into the chute.

5 Push-slide feeds, Fig. 4, are used where gravity and push feeds are not practical, due to the weight or shape of the blank. The blank is dropped into a guide, then pushed into the die, and positioned by means of a sliding member.

6 Magazine feeds are necessarily for production of parts where a large quantity is being made. The speed of production with magazine feeds is, of course, greatly increased. In this method a chute or series of guides is kept filled with parts to be worked upon and the bottom piece is fed into the machine by means of a slide fork similar to the push-slide feed.

7 In the rotary, or dial feed, Fig. 5, the part to be worked upon is placed in a fixture or positioning device and the whole is rotated by a ratchet or other similar device to a point under the die. The operator loads and unloads several inches away from the danger zone which can be effectively boxed in.

Hand Feeds. The hand feed is the most dangerous method of all and should be used only where and when absolutely necessary. It means that the piece must be placed into the die with pliers, tweezers, vacuum cup, etc., manually. The finished piece in a majority of cases has to be removed similarly.

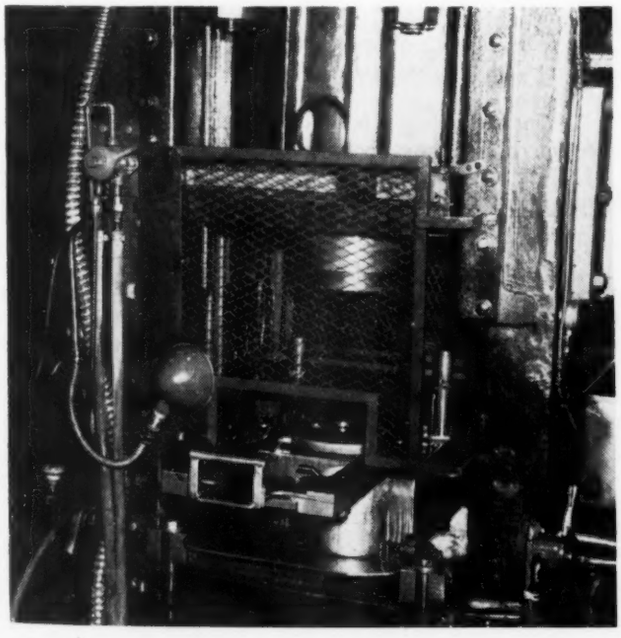


FIG. 4 THE PUSH-SLIDE FEED CONSISTS OF A MANUALLY CONTROLLED SLIDE ARM, ON WHICH THE BLANK IS DROPPED, THEN PUSHED INTO THE DIE AND POSITIONED BY MEANS OF A SLIDING MEMBER

(The operator's hands are several inches outside of the danger zone throughout the operation.)

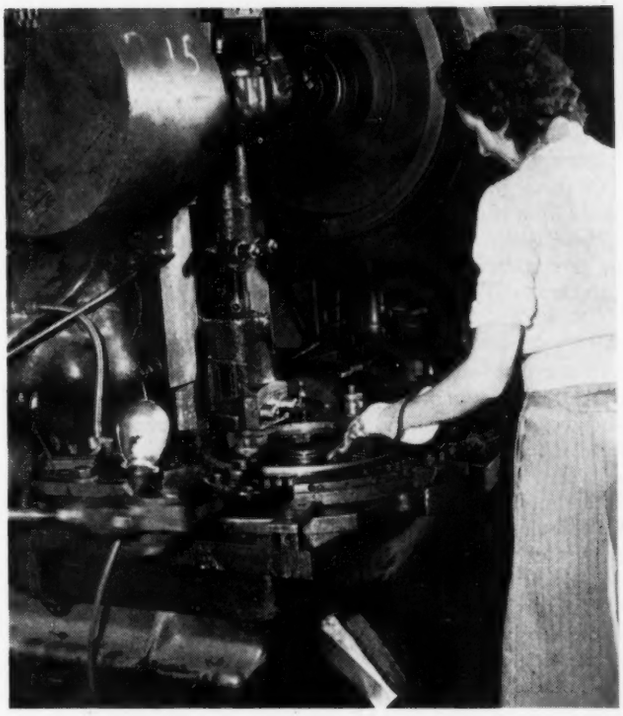


FIG. 5 ROTARY OR DIAL FEED IS LOADED AND UNLOADED SEVERAL INCHES AWAY FROM RAM, WHICH IS EFFECTIVELY BOXED IN

(The part to be worked upon is placed in a fixture or positioning device, and the whole is rotated by a ratchet or similar device to a point under the die.)

METHODS OF EJECTION

In any classification of feed, the method of ejection is an important phase of power-press work, both from a safety viewpoint and from that of economy. No press should ever be run automatically unless the blanks are positively ejected clear of the die on every stroke. With this in mind, only blank-through dies and those provided with a positive mechanical-sweep device or a safety shutoff device can be run automatically. Where gravity or compressed air is depended upon, the press should be so arranged that only one stroke of the press would result from each trip of the treadle, or press-operating lever. Strict observance of this rule would reduce the probability of a "miss," or a closing of the dies with two blanks between them, with the resultant severe springing or breakage of the dies, the crankshaft, or the press frame. Exception may be made for light materials or where the form or shape of the finished piece lends itself to positive ejection.

The fact should be emphasized that this rule would reduce the probability of a "miss." It does give the press operator an opportunity to see the ejection failure and to remove manually the completed punching with a wood or soft-metal stick before tripping the press again.

SPECIAL GUARDS OR OTHER MEANS FOR PROTECTING OPERATOR

The ideal guard is one in which it is not only unnecessary for the operator to reach into the danger zone, but it is impossible for him to do so. This is not always possible of accomplishment, so we compromise on a guard in which a maximum of safety is attained without interfering with production.

No guard will prevent the so-called "repeat stroke." For our purposes, a "repeat stroke" is one in which the press was not intentionally tripped. Guarding or means for protecting the operator properly falls into three classes, as follows:

Primary Guard. This type makes it impossible for the op-

erator to reach into the danger zone during the action of the ram. In other words, the danger zone must be completely enclosed before the press can be tripped.

Examples: Moving-gate guard, stationary guard.

Secondary Guards. The danger zone is guarded only during the time the ram is descending.

Examples: Sweep guard, pull-away, two-hand devices.

Of these guards, only the sweep and the pull-away remove hands from the danger zone if the ram descends unexpectedly

Hand Tools. Hand tools are devices used for manually feeding raw material into the press and removing finished pieces.

Examples: Pliers, vacuum cups, tweezers, etc.

DESCRIPTION OF GUARD TYPES

In the case of the moving-gate guard, Fig. 6, which is a typical primary guard, the gate is made of expanded metal or bar stock with openings too small to permit entry of the fingers. The clutch is tripped by the moving gate. Clutch tripping should take place at the lowest point of movement. A latch should be provided to hold the gate down until the ram has completed its stroke. Side pieces should also be provided to prevent reaching around the gate. The gate may be arranged for movement horizontally or vertically.

With stationary guards, another primary-guard type, the die is completely enclosed with material similar to that used with the moving-gate guard. A small opening is provided for feeding material to the die, but the guard is so arranged that it is impossible for the operator to reach into the die with the hands.

The first of the secondary guards to be considered is the sweep guard, which is composed of a flag attached to a sweep arm connected to the ram of the press. As the ram descends, the sweep swings across the front of the die.

Another form of secondary guard is the pull-away type which has cables leading to wristlets on the operator's wrists. The other end goes over suitable cam pulleys to the ram. As the ram descends, the operator's hands are pulled away from the danger zone.

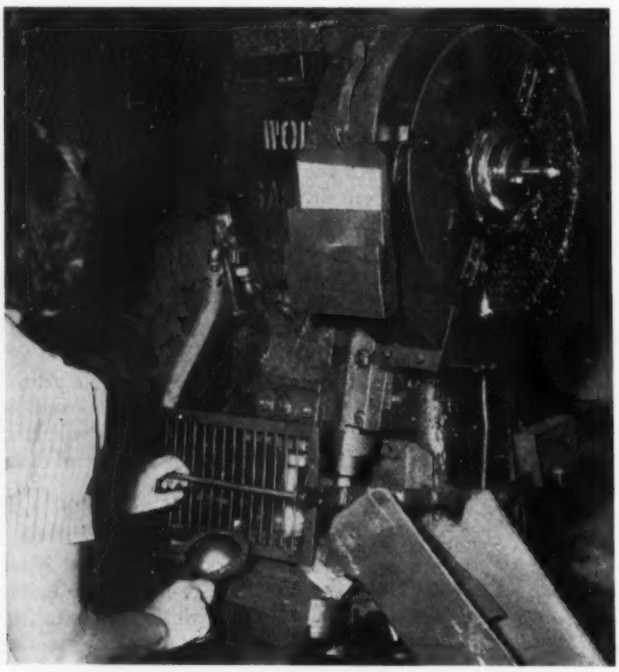


FIG. 6 MOVING-GATE GUARD IN COMMON USE THROUGHOUT PLANT
(The gate is made of expanded metal or bar stock, with openings too small to permit entry of fingers. The clutch is tripped when the moving gate is in a position blocking the die opening. A latch is provided to hold the gate down until the ram has completed its stroke.)

The sweep guard and the pull-away are the safest of the secondary type, as they effectively remove the hands from the danger zone in case of unexpected stroke. Their greatest drawback is that they must be properly adjusted for each setup. In the case of the pull-away, the operator himself can render it ineffective by forgetting to affix the wristlets.

Many variations of two-hand devices are in use. They may be electrical push buttons, air valves, or mechanical levers so arranged that both hands must be used to trip the press. They should also be so arranged as to make it impossible for the operator to tie either of them down, rendering them ineffective, or to reach either of them when his hands are in the danger zone.

To illustrate, if the controls were placed at the outer front corners of a small press, it might be possible for the operator to hold one down with his arm, thereby allowing the press to trip with his hand or fingers in the danger zone.

Hand tools, such as pliers, vacuum cups, tweezers, and other similar devices make it unnecessary for the operator to put his hands into the danger zone. They are by no means foolproof but are necessary under certain conditions.

All hand tools should be made of brass, copper, or other comparatively soft metal. They must not be made of tool steel or tempered material, because in case the ram descends on the tool the pieces might fly and injure the operator.

ADOPTION OF SAFETY REGULATIONS

Supervisors should observe these safety regulations:

(*a*) No press should be put into operation until safety devices, chutes, and other equipment have been installed.

(*b*) Periodic inspections should be made by men acquainted with operation and maintenance of punch presses, with authority to stop any machine considered unsafe.

(*c*) Safety devices and the clutch mechanism on any press are subjected to considerable vibration, wear, and abuse, so close checks must be made to maintain proper operating conditions.

(*d*) Maintenance of punch presses should be done only by men thoroughly trained and acquainted with all phases of press equipment.

(*e*) Operators should be instructed to call the supervisor's attention to any unusual behavior of equipment or tools.

(*f*) The supervisor should give immediate attention to any report concerning faulty equipment or tools.

Equivalent safety instructions for operators are as follows:

(*a*) At the beginning of each shift, or after an absence from the press, carefully try the press until satisfied that parts are working properly.

(*b*) Notify the supervisor of any unusual behavior of the equipment or tools.

(*c*) Make sure that all guards and safety devices are in place.

(*d*) Use equipment provided for feeding or removal of parts.

(*e*) If a piece sticks in the die, remove it with a stick or soft-metal tool, or report the matter to the supervisor.

(*f*) Do not tamper with the operating mechanism or safety devices.

(*g*) Stop the press to oil or make adjustments.

The four steps we have just considered in punch-press operations are: (1) Selection of the power press; (2) determination and design of type of die; (3) selection of a standard guard, design of a special guard for the particular job, or provision of other means for protecting the operator; and (4) adoption of safety regulations. With proper consideration of these steps, the author is quite sure that the number of accidents now occurring on punch presses will be greatly reduced.

A Suggested Design for MECHANICAL ENGINEERING CURRICULA

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ENGINEERING curricula in general take almost as many forms and directions as there are engineering schools. Frequently one is confused when comparing the programs of several institutions as to whether each is intended as a plan of study for the same field of endeavor. A prospective employer therefore often finds himself in doubt as to what he may expect from the products of such seemingly unrelated programs.

It is apparent that in the design of engineering curricula there appears a lack of application of care in preparing for a definite end. It can be expected that there will be a wide difference in the approach to this end, but there should be some definite principle of curriculum design for each field of practice in order that they present a uniform purpose.

The acceptance of a definite principle is especially desirable since engineering schools are now to be recognized on the basis of evaluation of their performance by an accrediting agency. The recent action of the National Council of State Boards of Engineering Examiners in classifying engineering-school graduates on the basis of E.C.P.D. accrediting of their alma maters makes this a public responsibility of the educators.

To accept a principle for a field of engineering practice does not necessarily mean the regimentation of schools into a definite pattern, thus limiting all curricula to a set formula or design. Such a principle should be better described as a more or less acceptable point of view of the functions of each curriculum.

The point of view accepted by chemical engineers is a good example of a principle for curriculum design and, whether applicable outside this field or not, may well be outlined here for purposes of illustration.

PRINCIPLES OF CHEMICAL ENGINEERING

In December, 1915, in a report to the corporation of the Massachusetts Institute of Technology, Dr. Arthur D. Little outlined a point of view concerning education for chemical engineering, at that time a relatively new field. Dr. Little's report received the attention that its cogency deserved. The acceptance of his point of view by the Massachusetts Institute of Technology established a formula for chemical-engineering education in all major engineering institutions of the country. This formula recognizes that the practice of chemical engineering involves certain so-called "unit operations." Quoting from an introduction written by Dr. Little in 1930 to "Elements of Chemical Engineering," by Badger and McCabe, "These unit operations are themselves physical rather than chemical in character, although directed toward an ultimately chemical result. They are comparatively few in number, but the conditions under which they may be conducted are of the most widely varying character, as determined by the nature of the material in process, the size of the operation, and the temperatures, pressures, and other factors involved in the process itself."

Badger and McCabe[1] summarize Dr. Little's point of view in the following statement:

> Coincident with the tremendous development of the chemical industries in the United States in the period between 1914 and 1920 (and probably to a large extent because of the intensity of this development and the pioneering nature of much of it) there came a realization that certain engineering operations were common to many processes that had previously been thought to occupy separate watertight compartments. It was recognized, for instance, that the transportation of liquids and the flow of heat were common to practically all processes. Filtration engineers discovered that a type of filter developed for use in the extraction of gold from gold ores was suited for filtration in most of the chemical industries. At the same time there also came a realization that many of these operations were little understood and that they all needed examination, development, and elaboration. As soon as this intensive research began, the fact that a given operation involved the same principles, no matter in what industries it might be used, became more apparent. Gradually, as it was recognized that a knowledge of these operations was the real key to an understanding of manufacturing processes, the field of the chemical engineer was recognized as covering unit operations. . . . . The replacing of a large list of independent manufacturing processes by a smaller list of general unit operations brings about a considerable simplification in the treatment of chemical engineering and therefore a greater power to those who have mastered the subject.

What has been the result of twenty-five years of the application of this principle to chemical engineering? The arbitrary demands of the American Institute of Chemical Engineers upon those institutions offering educational opportunities in their field have probably been quite annoying to many of us. On the other hand, their "hard-boiled" attitude in evaluating the character of instruction in this field has elevated the position of the chemical engineer in the industrial world, and has, in many cases, forced recognition of a vital principle of education upon engineering institutions.

What is this vital principle? It is simply the recognition that engineering related to manufacturing processes requires a versatility in engineering personnel beyond that of any other field, and further that engineering education must take a course that will supply graduate engineers to industry with an educational background that will stimulate diversity of effort.

It is agreed that the chemical engineers have had a splendid opportunity to develop this principle in their curriculum building. Their ideas sprang from a group of natural scientists whose industrial experiences indicated that the scientific laws

Contributed by the Committee on Education and Training for the Industries and presented at the A.S.M.E. Semi-Annual Meeting, Kansas City, Mo., June 16–20, 1941, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[1] "Elements of Chemical Engineering," by W. L. Badger and W. L. McCabe, McGraw-Hill Book Co., Inc., New York, N. Y., 1936.

learned in the classroom did not allow for the many variables that are to be encountered when placed into practice. It was, therefore, relatively easy for them to define the field of chemical engineering and to build a curriculum around this definition. Opposition did not come from industry or from engineers, but from the ranks of the natural scientists from which they sprang. But so strong and influential were the advocates of Dr. Little's principle that the chemical engineers have built up a defense that has successfully resisted the attackers. Those who subscribed to his point of view were in the beginning relatively few in number, but the soundness of the basic idea took hold and the American Institute of Chemical Engineers, through its Chemical Engineering Educational Committees, was emboldened to inaugurate an accrediting program for chemical-engineering curricula. Whether right or wrong, the institute has guarded its program zealously, and while joining with the Engineers' Council for Professional Development in the later accrediting program, it continues to control accrediting of chemical-engineering curricula. The result has been that only 39 curricula in this branch have been accredited today jointly by E.C.P.D. and A.I.Ch.E. out of a total of approximately 90 institutions offering degrees in this field. This strict application of the accrediting program has not met with the unqualified support of institutional administrative officers, but has assured the permanence of Dr. Little's principles.

This picture of the development of chemical-engineering education is not offered as the background for a procedure in mechanical-engineering curriculum building. Nor is it presented as an ideal process of education wholly worthy of emulation by other fields. It is, however, cited as an example of the success that may be attained by united adherence to a principle that governs the educational policy of a field of engineering practice. Do we mechanical-engineering teachers subscribe to a definitely well-formed principle? Perhaps we do; but is it sufficiently well defined to be used as a guide in our curriculum building?

EVOLUTION OF MECHANICAL-ENGINEERING EDUCATION

Let's look for a moment at the history of mechanical engineering and at the educational program that has evolved. It may be said that the field of mechanical engineering sprang from an entirely different source than that of electrical and chemical engineering. Unlike these two more youthful pursuits, mechanical engineering gained recognition as a scientific art through the realization of nonscientific artisans that the fruits of their skills were limited in use by lack of a scientific background. It was more of an evolution than a creation. A premium was placed upon empirical invention, and it has been only in comparatively recent years that rationalization of many early developments has come about.

This course is the usual one in all old and honored fields of applied science. It is true in medicine as well as in mechanical engineering. Theories were developed and offered as the reasons behind many specific accomplishments. Often the reasoning made to back up a theory was found to break down when an attempt was made to extend its application. Acceptance of theories developed in this manner limits the versatility of those whose background cannot go beyond them, and results in needlessly placing many practices in "watertight compartments."

The educational system that has evolved may be described as consisting of two years of elementary fundamental sciences, followed by two years of specialized instruction in certain engineering practices. It is natural that this should be the case in a system that is not a creation, but an evolution. On the other hand, is it the best system that can be devised for the purposes of education for a definite field of engineering?

Suppose we assume that the 103 accredited curricula in mechanical engineering are well-balanced and performing a good service for those aspiring to enter the practice of mechanical engineering. Then ask ourselves the question: Have we sufficiently defined the practice of mechanical engineering to make this assumption valid, or to accurately evaluate these curricula?

DIVERSITY OF MECHANICAL ENGINEERING

A glance at the professional divisions of The American Society of Mechanical Engineers indicates that the members of the society have organized themselves into seventeen different groups of interest. These divisions are so general in title that they cover almost as many more separate groups within each division. Perhaps there is no other branch of engineering that covers as diversified a field of effort. None of us would wish to limit these endeavors by a too strict definition of the field. But we can evolve a principle, or theory, or even a philosophy covering the field of mechanical-engineering education that will create a greater versatility in our graduates and give to them greater opportunities for entering the many diverse avenues of interest.

In 1936 the A.S.M.E.[2] published the findings of an occupational survey covering approximately 50 per cent of its membership. A breakdown of the data obtained, liberally interpreted, indicates employment activities approximately as follows:

	Per cent
Production supervision and control	29.50
Design, research, and testing	27.15
Professional and educational	21.82
Technical selling and buying	8.24
Industrial administration	7.74
Commercial and nonengineering	5.55

These figures are well known to all and are offered only to round out the picture of the character of the work performed by mechanical engineers in each of the seventeen, or more, fields of endeavor represented by the professional divisions of the A.S.M.E.

It may be argued that, because of the extremely wide variation in the activities of the mechanical engineer, it will be impossible to adopt a principle of education that will be sufficiently broad and comprehensive to fulfill all the needs dictated by the activities of our profession. On the other hand, the need for the universal acceptance of a theory or philosophy of mechanical-engineering education is actually made acute by the very immensity of the problem. It is difficult to see how improvement in our programs can be effectively made unless a guide is provided for the attainment of a definite goal.

SUGGESTIONS FOR A GUIDE IN CURRICULUM BUILDING

In order to start a discussion, some basic principles are suggested that may be considered as guides to a program of mechanical-engineering education covering a four-year period of instruction.

1 A definition of the mechanical engineer as a member of a scientific fraternity whose basic functions deal with the transformation of energy into work and with the mechanisms by which this may be accomplished.

2 That the education for these basic functions should include instruction in those natural and engineering sciences that deal with manifestations of energy and with the forces into which they may be transformed during the process of conversion into work.

3 That the fields of practice of this scientific art contain

[2] "The A.S.M.E. Member's Job," MECHANICAL ENGINEERING, vol. 58, March, 1936, p. 162.

many simple practices, common to almost all, and further that educational effort should be directed toward an intensification of instruction in those practices considered as the principal ones of mechanical engineering.

4 That economy guide the applications of these classified practices in mechanical engineering.

Do not make the mistake of thinking that by these suggestions, wholehearted emulation of the chemical engineers is advocated. With the acceptance of Dr. Little's point of view concerning engineering education, emulation might well cease. On the other hand, all branches of engineering might well adopt his point of view to the betterment of engineering education.

The chemical engineers themselves disagree as to the place of "unit operations" in their educational program. Perhaps a criticism of their plan might well be that many of them place too great a reliance on these "simple operations" and consider that an understanding of the principles involved in them makes a chemical engineer.

But to return to mechanical engineering and a philosophy of our own. Having suggested four basic principles, these should be enlarged upon with special reference to the second, third, and fourth.

As for the first, undoubtedly mechanical engineering can be better defined. This definition is only offered in recognition of the fact that in order to have a philosophy of education for the field, it should be defined.

In stating the second principle, the humanities have been purposely neglected in order to try to confine consideration to certain subjective course material. Let us then consider only the sciences here. It is admitted that the wording of number two is perhaps too all-embracing. But at least we can "cut and try" and *perhaps* arrive at an agreement concerning what sciences should be taught, and the recognition they should receive in our educational program. We are perhaps already agreed as to "what sciences should be taught" but probably we are as far apart as the poles concerning the "recognition they should receive."

NATURAL AND ENGINEERING SCIENCES

For convenience of discussion, there are listed here the natural and engineering sciences that seem appropriate as covering those "dealing with manifestations of energy and with the forces into which they may be transformed."

Natural sciences:	Mathematics (calculus, through differential equations), physics, physical chemistry
Engineering sciences:	Physical metallurgy, mechanics, heat transfer, fluid flow, thermodynamics

It will be noted that mathematical requirements start with the calculus, implying, of course, that the institution unable to draw students from those who have already received adequate instruction in its prerequisites must supply that lack. Those students who have been so prepared form the exception rather than the rule.

Some subjects classed as engineering sciences might well be placed under the natural sciences, but they have been separated intentionally for the purpose of suggesting that the method of approach might determine the classification.

Much time need not be spent on a discussion of the sciences suggested. This list does not present any startling innovations. Each of the subjects may be found included in one or more mechanical-engineering curricula and most of them in all. A discussion as to relative value would probably center around the subjects of differential equations, physical chemistry, heat transfer, and fluid flow.

Many mechanical-engineering curricula extend mathematical instruction to include the equivalent of one semester of differential equations. This in itself is a recognition of the rationalization of the art, and it can easily be included in the instructional program as an instrument for an understanding of the derivation of engineering formulas presented in specialized courses, if not as a tool for the expression of physical phenomena met with in engineering practice. It is hard to see how, whatever the principles of education accepted, mechanical engineering can be adequately taught without extending mathematics instruction beyond a two-semester course in differential and integral calculus. In discussions of this matter among engineering educators, few are to be found who do not agree that this extension is desirable, but there are many who feel that it is not essential.

There has grown up, through the years, a more or less standardized chemistry course called "general chemistry," required of all engineering freshmen. As offered at many institutions it consists of about two-thirds inorganic chemistry and one-third qualitative analysis. It usually consists of the study of many elements and the compounds of these elements. Included in the program of instruction is a laboratory course following rather well-established experiments. In some institutions, two years of chemistry are required, with the second for mechanical engineers devoted to quantitative analysis.

There is no intent to suggest that chemistry should be stricken from the mechanical-engineering curriculum. On the other hand, attention is called to another form of chemistry than that usually offered that is perhaps more nearly suited to engineering practices. This may be defined as "theoretical" or "physical" chemistry which has for its object the study of laws controlling chemical phenomena. It deals with engineering media in the form of gases, liquids, vapors, and solids. In its very elementary form it offers a splendid background for a study of the laws involved in energy relationships. Fortunately for us, there are texts in this field so written that they may serve the purpose of a freshman course, containing all the chemical concepts of the standardized general chemistry together with the more objective characteristics of physical chemistry.

Whether one year of chemistry is sufficient background for preparation for mechanical engineering is a matter for argument. Certainly two years of chemistry without the physical concept is offered at the expense of more valuable background material. In one engineering school's mechanical-engineering curriculum, one semester of physical chemistry follows a year of the standard general chemistry of the freshman year. Preparation for a field of engineering primarily concerned with energy transformation of engineering media cannot properly neglect this field of study. And yet those mechanical-engineering curricula that do so are far more numerous than those that do not. There is no denying that a course in physical chemistry, beyond the very elementary concept contained in the freshman course just described, would tend toward preparation for a greater versatility in engineering practice.

We are frequently told that heat transfer is a field for graduate study; that it is too difficult a subject in its rational form for the undergraduate student. If we accept this view, we may well be accused of accepting mechanical engineering, in the majority of its practices, as an empirical art. Improvements and advancement in the process of transformation of heat energy into work can only come through development in this all-important field. If for no other reason, it should be a part of the undergraduate curriculum as an illustration of how the variables of engineering phenomena may be studied rationally and their effects experimentally determined.

For the same reason, fluid flow should be included in the undergraduate curriculum, containing, for clarity, dimensional analysis as the background for analytical study of physical

variables. If it became necessary to sacrifice the conventional course in hydraulics for work in these two fields, we may well do so without shedding a single tear.

Honesty demands the confession that text material in these two fields is sadly lacking for undergraduate teaching. Especially is this true in heat transfer. However, if the demand is created, the texts will flow forth, and knowledge is such today that elementary texts on the undergraduate student level can and should be provided.

Thermodynamics is, of course, a major background study. To provide versatility in energy transformation, this subject should be presented as dealing with the energy relations of thermodynamic media. For greater versatility in engineering practice, thermodynamics should be considered and taught in a much broader manner than is the practice in many mechanical-engineering curricula. In the process of evolution of education for the practice of mechanical engineering, thermodynamics has been considered in many places as an applied science and limited in its presentation to those media commonly met in the power plant. It is a specialized field of physical chemistry and should be included in our mechanical-engineering curriculum in a manner that will provide the student with the greatest amount of versatility in its use.

PRINCIPAL PRACTICES OF MECHANICAL ENGINEERING

Accepting a definition of mechanical engineering as the one presented earlier in this article, a chart has been prepared which divides the engineering sciences into two groups, a "machine-design group" and an "energy-transformation group," each containing curricula subjects that must be synthesized into what are called "applied fields." This is an attempt to show that each of these applied fields, and many not shown, is a synthesis of engineering sciences, which when placed into practice may be called the "principal practices of mechanical engineering."

In order that intensification may be had in these practices, laboratory instruction should be pointed in this direction with less emphasis on tests of machines of commercial nature.

R. A. Seban,[3] instructor in mechanical engineering, University of Santa Clara, presented a paper at the S.P.E.E. 1940 annual meeting, outlining laboratory procedure in "unit operations." He listed as these operations:

Heat transfer (conduction, convection, radiation)
Thermodynamics (paths, cycles, energy transformations)
Mechanics and thrusts (isothermal flow, lubrication, acoustics)
Mechanics of solids (statics, dynamics, vibration)
Elasticity (stability, vibration)

Mr. Seban described several laboratory experiments of an analytical character that well illustrate the principles of many engineering practices that are synthesized into applied fields. Major laboratory effort might well be analytical in character and largely directed toward these principal practices under the two groups (machine design and energy transformation) rather than tests of standard apparatus.

The following quotation is from a letter recently received from an engineering executive of one of the country's largest utility concerns. He had just completed an interview with an engineering graduate of high scholastic standing. This is one sentence from that letter: "Practically all of the few technical questions I asked . . . . he answered through the medium of formulas and seemed to evidence that he did not have a pictured concept of the problem and the *physical relationships* involved."

This statement, while made in regard to a specific graduate, may well be said of many. This fault, and it is a common one, can be overcome by a careful study of our educational problems, and by a recognition of the fact that mechanical-engineering curricula must be *designed* rather than *evolved*.

Fig. 1 has been drawn to close with engineering economy in

(*Continued on page 599*)

[3] "Unit Operations Apparatus in Mechanical Laboratory Instruction," by R. A. Seban, *Journal of Engineering Education*, November, 1940, pp. 213–224.

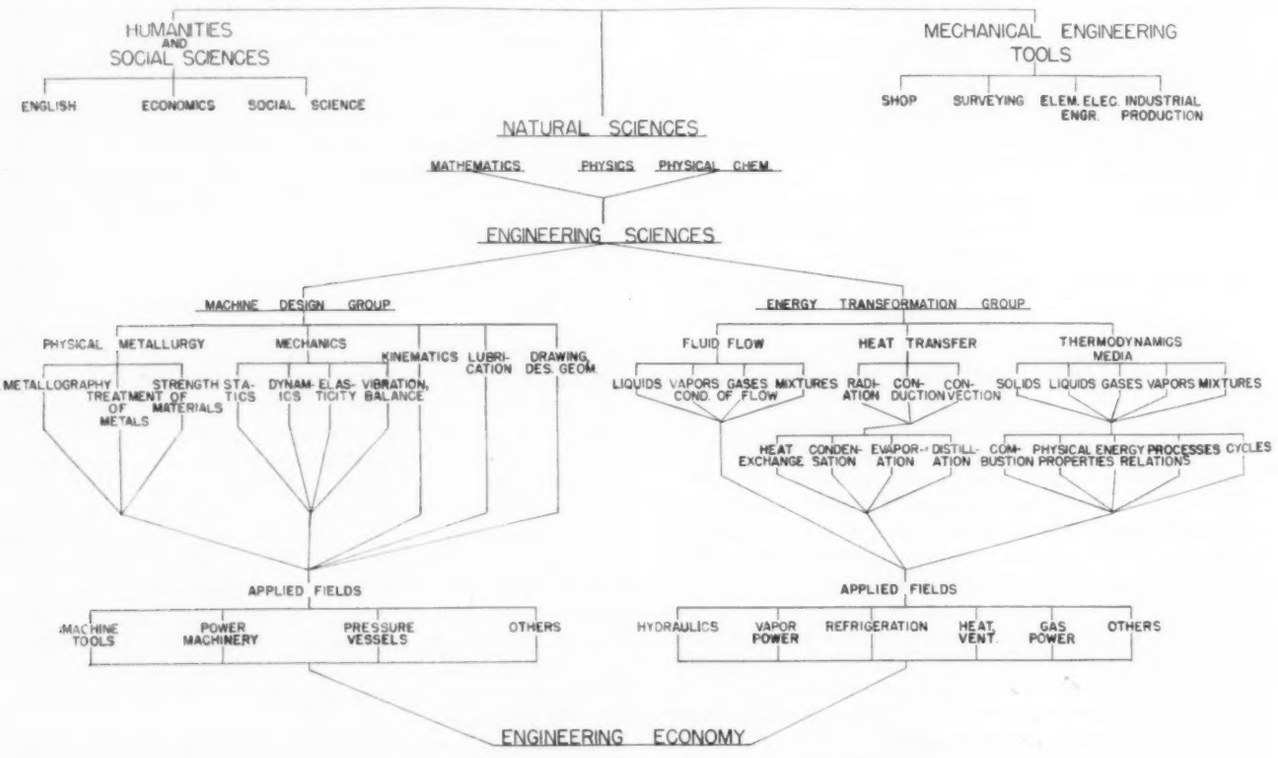

FIG. 1 A SUGGESTED DESIGN FOR MECHANICAL-ENGINEERING CURRICULA

Some Metallurgical Aspects of METAL-ARC WELDING *of* CARBON *and* ALLOY STEELS

By T. N. ARMSTRONG

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UNTIL the development of covered electrodes, little attention was directed to the welding qualities of different steels, as it was unusual for failure to occur outside of the deposit when welded with the metal arc. Although adequate for many purposes, these welds were brittle and rarely equaled the strength of the base metal. With the introduction of covered electrodes, it was possible to obtain welds with good ductility and toughness. It was soon discovered, however, that use of covered electrodes was not a panacea for all welding troubles.

To understand fully why some steels may be welded readily while difficulties occur with others, it is necessary to have some knowledge of the metallurgical factors involved. By applying this knowledge, it may be possible to change conditions so that satisfactory welds may be made on steels which are generally considered to have poor weldability.

WHAT OCCURS IN METAL-ARC WELDING

In making a weld, a small area of the base is heated to above the melting temperature. Filler material, in the form of the electrode, is also melted locally by the arc and fuses with the molten surfaces of the base. It is obvious that the parent metal adjacent to the weld will become quite hot. As the arc is moved away from this location, the weld and the metal adjacent to the weld cool very rapidly by conduction. Although no change has occurred in the composition of the parent metal in the heat-affected zone, except to a limited extent at the fusion line, decided changes have occurred in the physical characteristics. It is these changes in properties in the heat-affected zone of the parent metal which affect to a large degree the welding characteristics of steel.

One of the principal sources of trouble in welding is cracking. When welds are made with covered electrodes, cracking usually occurs in the heat-affected zone of the parent metal. Unfortunately, such cracks cannot always be detected by the usual inspection tests and their presence may lead to disastrous failures. That these cracks do occur and may be difficult to detect is illustrated in Figs. 1 to 6, inclusive.

Figs. 1 and 2 show a welded section cut from a casting. There was no indication on the surface that the weld was not sound, but when the part was machined on the back side the cracks were discovered.

Figs. 3 and 4 illustrate hairline cracking in the heat-affected zones of welds made on S.A.E. steels 3340 and 1050. Even when extending to the surface, it is doubtful if these cracks would have been detected by casual inspection.

Presented at a meeting of the Iron-Steel-Welding Division, Metropolitan Section, New York, N. Y., February 27, 1941, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Very fine cracks that may propagate under applied stress are illustrated in Fig. 6. These cracks occurred in a steel that had been quenched. Since the same constituent, martensite, occurs in the heat-affected zones of many steels on welding, most welding cracks undoubtedly are similar to the cracks shown in Fig. 6, but enlarged by cooling stresses.

EFFECT OF CARBON ON WELD HARDNESS

No steels are completely immune to cracking, but the trouble can be avoided to a great extent by adjusting welding conditions and by selecting steels that do not harden appreciably

FIG. 1 WELDING CRACK BENEATH WELD IN 0.40 PER CENT CARBON CAST STEEL

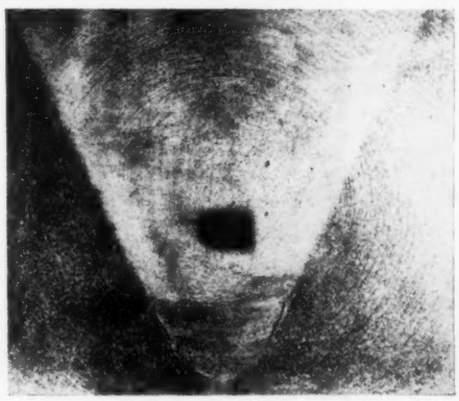

FIG. 2 SECTION THROTUGH HEAVY WELD IN 0.40 PER CENT CARBON CAST STEEL

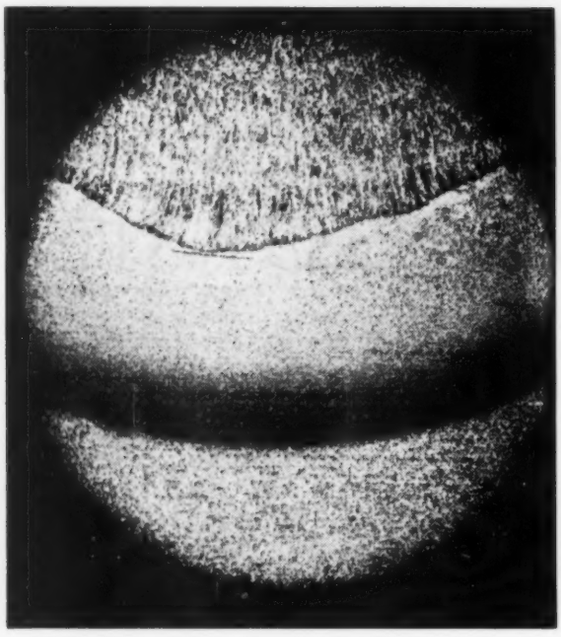

FIG. 3 CRACK IN HEAT-AFFECTED ZONE OF S.A.E. 3330; ×100

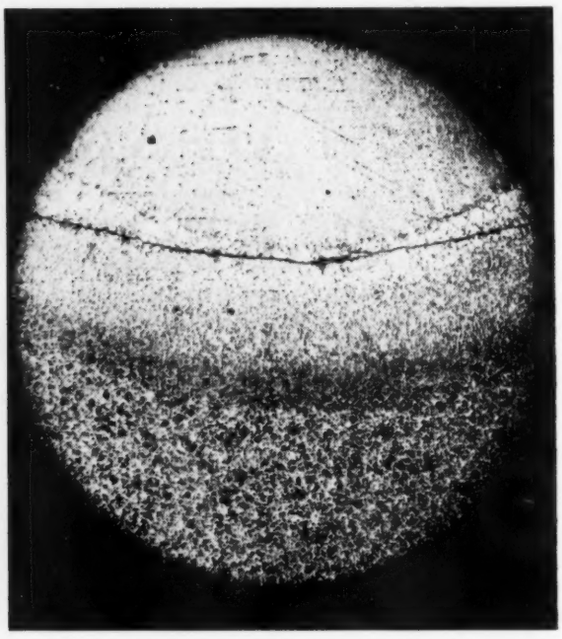

FIG. 4 CRACK IN HEAT-AFFECTED ZONE OF S.A.E. 1050; ×100

when welded. In this connection, it is logical first to consider the effect of carbon on weld hardness. Increase in carbon in any steel increases its hardening tendencies and higher hardening capacities are developed. The hardening capacity of a steel may be considered the maximum hardness obtainable, which results when the steel is fully martensitic, and is dependent almost entirely upon carbon content. The hardening tendency is the degree to which the hardness approaches the maximum hardness obtainable under certain conditions.

The effect of carbon on weld hardness is shown graphically in Fig. 7. The bottom line represents the hardness of as-rolled carbon steel. The top line represents the maximum hardness developed in the same steels on welding single beads at a rate of 4 to 6 in. per min with $^3/_{16}$-in. covered electrodes.

It will be noted that the hardness of as-rolled carbon steel increases almost uniformly, and rather moderately, with increase in carbon. On welding, there is no marked hardening with carbon contents below 0.25 per cent but, with increase in carbon above this value, the maximum weld hardness increases rapidly. Details of plate dimensions and location of specimen for hardness determinations are shown in Fig. 8.

It is recognized that weld hardness secured in this manner is not the only method of determining welding characteristics of a steel, but as single surface beads produce the maximum

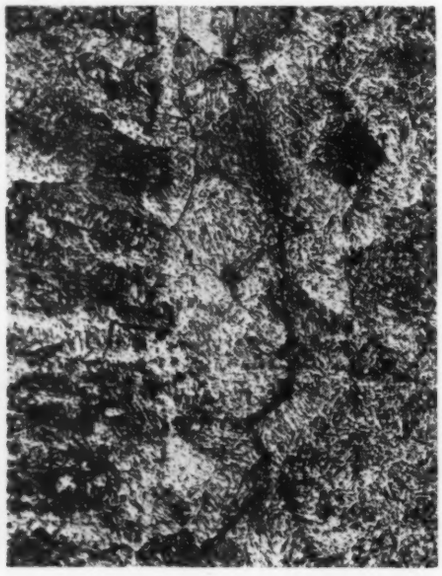

FIG. 5 CRACK IN HEAT-AFFECTED ZONE OF WELDED S.A.E. 1040; ×50

FIG. 6 TYPICAL MICROCRACK IN HIGH-CARBON MARTENSITE; ×1500 (ABORN)

weld hardening, and as high weld hardness is accompanied by brittleness, the method described is a simple one by which to compare the weldability of different steels. No arbitrary limit of hardness for safe welding can be set, since higher hardness may be tolerated in some applications more than in others. Usually, maximum Brinell hardness between 250 and 300 is considered the safe limit.

While a given set of conditions is useful in determining the welding characteristics of a given steel, and is essential in comparing different steels, such conditions do not prevail in production welding. There are other variables than carbon which affect weld hardness. These variables may be size of section, speed of welding, current density, temperature of material being welded, and alloy content.

OTHER FACTORS INFLUENCING HARDNESS OF WELDS

To determine the effect of alloying elements on weld hardness, tests were made similar to those already described for carbon steel. Steels with different percentages of a particular alloy at different carbon levels were welded and the hardness determined. From these data, curves were plotted, such as shown in Fig. 9. These curves, however, permitted comparison between only carbon steel and the particular alloy steels being studied. To make a comparison of the effect among the different alloys, the derived curves, in Fig. 10, were prepared. The slopes of the several curves indicate the effect of alloying elements on weld hardness. The very potent effect of carbon will again be noted, with molybdenum, manganese, chromium, and nickel in descending order of effectiveness when considered on a weight-percentage basis. As manganese is present in practically all steels, the effect of this element when present in quantities below 0.70 per cent was not determined.

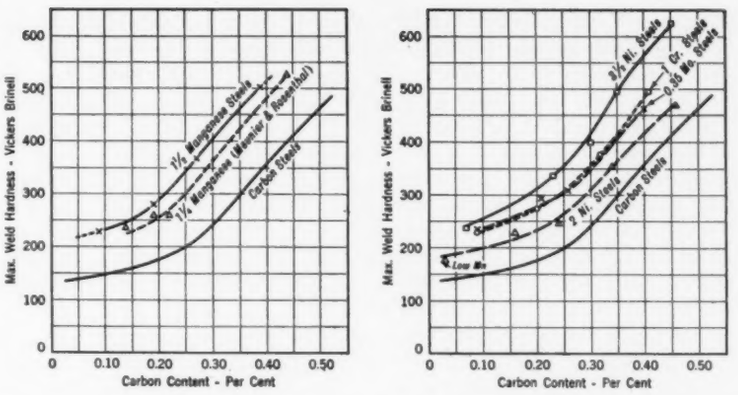

FIG. 9 MAXIMUM WELD HARDNESS IN $^1/_2$-IN. PLATES OF CARBON STEEL, AND IN MANGANESE, CHROMIUM, MOLYBDENUM, AND NICKEL STEELS

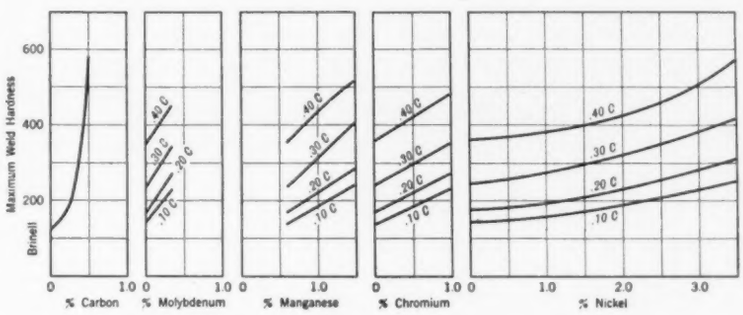

FIG. 10 EFFECT OF CARBON, MANGANESE, CHROMIUM, MOLYBDENUM, AND NICKEL ON WELD HARDENABILITY OF STEELS CONTAINING DIFFERENT CARBON CONTENTS

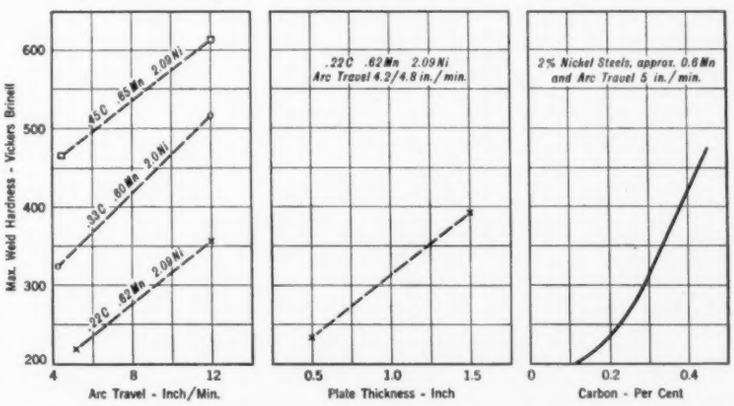
Max. Weld Hardness - Vickers Brinell
Arc Travel - Inch/Min.
Plate Thickness - Inch
Carbon - Per Cent
.45 C .65 Mn 2.09 Ni
.32 C .80 Mn 2.0 Ni
.22 C .62 Mn 2.09 Ni
.22C .62Mn 2.09Ni
Arc Travel 4.2/4.8 in./min.
2% Nickel Steels, approx. 0.6 Mn and Arc Travel 5 in./min.

FIG. 11 MAXIMUM WELD HARDNESS OF 2 PER CENT NICKEL STEELS AS AFFECTED BY ARC-TRAVEL SPEED, PLATE THICKNESS, AND CARBON CONTENT

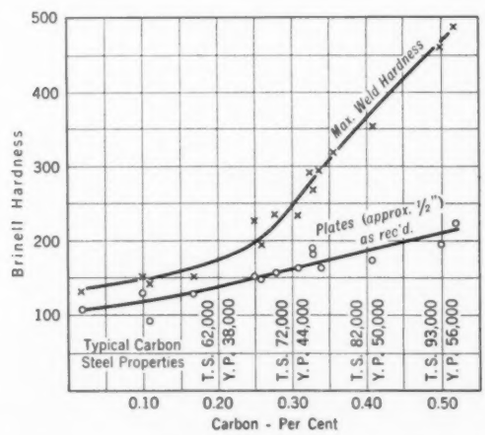

FIG. 7 EFFECT OF CARBON CONTENT IN PLAIN CARBON STEELS ON WELD HARDENING

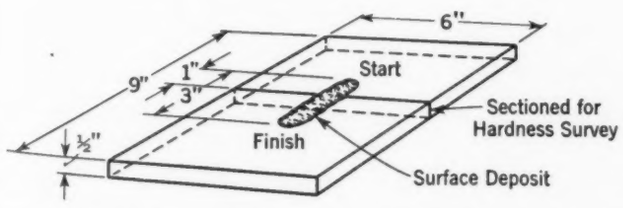

FIG. 8 SKETCH SHOWING METHODS USED IN DETERMINING WELD HARDENABILITY

The effects of welding speed and plate thickness are compared with the carbon effect in Fig. 11. As the slopes of the curves, representing hardness increase with faster welding speeds, are approximately parallel, the inference is that increase in arc travel increases the hardness in about the same ratio at any carbon level between 0.20 and 0.45 per cent carbon. These steels contained 2 per cent nickel, but the same general trend has been observed in plain carbon steels.

The increase in hardness, due to increasing plate thickness from $^1/_2$ in. to $1^1/_2$ in., is quite marked, the reason being that the heavier section conducts the heat away much faster than the

lighter one. It is obvious that there is an optimum section size beyond which any increase will not further affect weld hardness. Also, very small sections may become red-hot on welding and, unless the parent metal has decided air-hardening tendencies, weld hardness will be low.

The evidence proves quite conclusively that carbon is the most potent factor in promoting weld hardness. Because of this, the strength properties of plain carbon steel of good welding characteristics are somewhat limited, as shown in Fig. 7. To secure higher strength properties without sacrificing weldability, there has been developed a group of low-carbon, low-alloy steels which have much higher elastic properties than carbon steels of equal strength but, because of limitations on carbon, the welding qualities of low-carbon, plain carbon steels are approached. Analysis and typical properties of some of these steels are shown in Table 1.

These steels not only have the advantage of better welding qualities than the higher carbon, plain carbon steels, but possess better forming properties and are more resistant to atmospheric corrosion. Most of these steels contain copper, which improves the elastic properties and corrosion resistance. As steels containing appreciable quantities of copper are difficult to roll, many of these steels also contain nickel, which, in addition to improving mechanical properties and corrosion resistance, counteracts the detrimental effect of copper on rolling.

WELDING QUALITIES OF HIGH-TENSILE LOW-ALLOY STEELS

Most of the high-tensile low-alloy steels are marketed with a guaranteed yield point of 50,000 psi in sections up to about $^3/_4$ in. thickness. These steels have been used extensively in lightweight welded construction of railroad passenger and freight cars, steam shovels, dipper buckets, truck frames and bodies, drill pipe, and many other applications where light weight and resistance to corrosion are advantageous.

Another group of low-alloy steels which must possess good welding qualities includes those steels having special properties, such as resistance to creep at elevated temperatures or resistance to embrittlement at subzero temperatures. Practically all low-alloy steels for service at temperatures between 800 and 1100 F contain molybdenum (or tungsten). Other alloys are sometimes present in addition to molybdenum to stabilize the structure, to secure higher room-temperature strength, or to resist oxidation. The carbon-molybdenum steels can be welded without difficulty providing the carbon is limited. The type of weld and whether a stress-relief anneal can be applied have some influence on the maximum allowable carbon. It is generally accepted that carbon-molybdenum steels containing $^1/_2$ per cent molybdenum and not over 0.25 per cent carbon do not require preheating. The more complex molybdenum-alloy steels usually have high hardening tendencies and as a rule are preheated.

The most important effect of low temperature on the engineering properties of steel is a marked tendency to induce brittleness. Down to at least —150 F, strength, endurance limit, and elastic properties are steadily increased, with little or no change in ductility, but the accompanying drop in notched-bar impact may, and frequently does, amount to more than 90 per cent of the values at room temperature. Realization of this fact is of importance in the construction of apparatus used in industrial processes involving reduced temperatures, such as certain operations in oil refining, liquefaction of gases, etc., also for machinery parts operating in cold climates in winter.

TABLE 1 PROPERTIES AND WELD HARDENING OF SOME LOW-CARBON NICKEL COPPER STEELS

($^1/_2$-In. plates)

Composition, per cent						Yield[a] point, psi	Tensile[a] strength, psi	Plate[a] hardness	Maximum weld hardness
C	Mn	Si	Ni	Cu	Mo				
0.09	0.70	0.03	0.75	1.40	0.11	65000	74000	190	220
0.12	0.56	..	2.01	1.07	..	58000	78000	190	263
0.11	0.46	0.98	1.05	0.94	..	63600	78000	202	278
0.10	0.97	0.97	1.00	1.03	..	61400	74750	183	286
0.12	0.57	0.17	1.00	1.05	..	53300	69500	160	223

[a] Typical properties, normalized; welds made with $^3/_{16}$-in. covered mild-steel electrodes; speed of arc travel, 6 in. per min; 180 amp.

TABLE 2 TENSILE AND LOW-TEMPERATURE IMPACT PROPERTIES OF SOME COMMERCIAL ALLOY-STEEL BARS

(Numbers in parentheses are estimated values)

Size	Type steel	Composition, per cent					Heat-treatment, F	Mechanical properties								
								Yield[a] point, psi	Tensile strength, psi	Elon. in 2 in., per cent	Red. area, per cent	Bhn	McQ-Ehn	Impact, ft-lb, Charpy, keyhole notch— Room temp, F	—100 F	—150 F	—200F
		C	Mn	Si	Ni	Mo										
$1^1/_8$-in. rounds	Low C, 2 per cent Ni	0.05	0.17	0.01	2.11	....	1625 ac, 1200 ac	39000	53700	41.0	72.8	106	1–2	57, 59	34, 34	20, 20	3, 5
3-in. rounds	Low C, $2^3/_4$ per cent Ni	0.13	0.44	0.20	2.69	....	1575 ac, 1200 ac	53000	71200	36.5	72.8	144	8	59, 60	37, 39	35, 37	23, 26
$1^1/_4$-in. rounds	Low C, $3^3/_4$ per cent Ni, Mo	0.05	0.13	0.15	3.72	0.21	1600 ac, 1200 ac	43200	63500	40.5	77.6	130	1–2	70, 71	41, 45	6, 14	4, 5
$2^1/_2$-in. rounds	Low C, 5 per cent Ni, Mo	0.09	0.86	0.22	5.35	0.34	1575 ac, 1200 ac	51000	108000	26.0	65.9	217	7	58, 64	35, 41	27, 35	20, 22
$^3/_4 \times 2$ in.	Deposited weld metal, vertical weld	(0.12)	(0.50)	(0.02)	(2.25)	0.21	1150 ac	55700	70700	29.7	53.9	146	2–8	26, 30	11, 22, 26, 26	19, 20	13, 16
$^3/_4 \times 2$ in.	Deposited weld metal, flat weld	(0.12)	(0.50)	(0.02)	(2.25)	0.21	1150 ac	52000	68600	34.0	64.5	139	2–8	33, 33	18, 23	14, 21	3, 3

[a] Extension, 0.01 in.

Nickel toughens steel markedly at low temperatures, which has led to general acceptance of nickel steels for low-temperature applications.

Much of the equipment used for low temperature is fabricated by welding. Fortunately most of these steels have very low carbon, as carbon in steel is detrimental to toughness at low temperatures. For temperatures down to about —100 F, steel containing approximately 0.20 per cent maximum carbon and $2^1/_4$ per cent nickel is generally used. For lower temperatures, a steel containing a maximum of 0.12 per cent carbon and $3^1/_2$ per cent nickel is employed. This steel has been used successfully at temperatures of —150 F and there is record of its use at temperatures as low as —250 F, however, the general practice is to use austenitic nickel-chromium steel or a nonferrous metal at a temperature of —200 F and below. Attention is called to the lower carbon limit in $3^1/_2$ per cent nickel steel than in the steel with $2^1/_4$ per cent nickel. Although the reason for this is primarily to secure high impact at low temperatures, it fits in very nicely for welding. Referring again to Fig. 10, it will be observed that, as nickel approaches 3 per cent, there is a slight curve upward in the hardening trend. This and other factors involved do not permit welding of $3^1/_2$ per cent nickel steels under as wide a range of conditions as steels of the same carbon content that have about 2 per cent nickel or less.

For temperatures of —100 F and slightly below, welding rods which will give a deposit containing low carbon and over 2 per cent nickel have been found satisfactory. There are several commercial rods available and analysis and properties of a weld made with one of these is shown in Table 2. For temperatures much below —100 F, austenitic-steel electrodes containing 25 per cent chromium 20 per cent nickel are used.

All welded structures used for low temperatures should be stress-relieved, as residual stress contributes to brittleness in steel at subzero temperatures at room temperatures as well.

EFFECT OF PREHEATING ON WELD HARDNESS

At times, it becomes necessary to weld steels that, under ordinary conditions, would not be considered suitable for welding. Weldability is only a relative term and, although some steels are more difficult to weld than others, almost any steel may be welded if welding conditions are properly controlled. Steels which are difficult to weld generally have either high carbon or sufficient carbon and alloy to make them decidedly weld-hardening under normal conditions. To weld such steels satisfactorily, it is necessary to lower the weld-hardening tendencies, and one of the simplest means of doing this is by preheating.

The effect of preheating on weld hardness of two steels with high hardening tendencies is quite clearly shown in Table 3. Preheating the carbon steel, S.A.E. 1050, to 700 F was sufficient to lower the maximum weld hardness to approximately 270 Brinell from a weld hardness of 500 Brinell when welded at room temperature. The maximum weld hardness of the S.A.E. 3330 never fell under 330 Brinell, even when preheating temperatures as high as 1250 F were applied. This indicates a need for controlled cooling after preheating and welding alloy steels of this type.

WELDING HIGH-STRENGTH S.A.E. ALLOY STEELS

Considerable interest, particularly at this time, has been evidenced in metal-arc welding the high-strength S.A.E. alloy steels. A great deal of progress has been made in welding these steels with oxyacetylene and with atomic hydrogen, but satisfactory metal-arc welding is still in the development stage. One reason why greater success has not been realized is that the applications require the strength of the weld to approach the strength of the parent metal after the parts are quenched and tempered. This requires a filler material of analysis similar to the analysis of the parent metal. Unfortunately, such welds are brittle in the as-welded condition.

Steels such as S.A.E. 6130, X4130, 4140, 4340, 3140, and 4640 have high hardening tendencies and will develop high strength properties when quenched and tempered. Some of these steels are used extensively in structural parts of aircraft and in other applications where high strength properties are essential. The effect of preheating to 600 F on the weld hardness of several of the constructional-type S.A.E. alloy steels is given in Table 4. Gas welding until recently had been applied to steels used in aircraft construction, not because welds made with oxyacetylene have higher properties than arc welds but, in welding thin-wall pipe and tubing and thin-gage strip, it is difficult to prevent the arc from penetrating excessively through the material. Also, lower hardness usually results from gas welding than from arc welding. Improved technique has been developed and aircraft tubing of S.A.E. X4130 and 4330 is now being welded successfully by the metal-arc process.

TABLE 4 WELD-HARDENING IN $^1/_2$-IN. PLATE OF SOME S.A.E. NICKEL-ALLOY STEELS

S.A.E. No.	4640	4340	4330	4320	4615	3115
Annealed plate hardness	180	221	160	148	218	146
Maximum hardness of plate welded at room temperature	673	788	660	418	294	267
Maximum hardness of plate welded at 600 F	353	660	376	294	...	...

NOTE: Welds made with $^3/_{16}$-in. mild-steel covered electrodes, 180 amp; speed of arc travel 6 in. per min.

TABLE 3 HARDNESS DATA

		Brinell hardness numbers							
		S.A.E. 1050			S.A.E. 3330				
Size rod, diam, in.	Temperature of base, F	Bead	Hardened zone	Unaffected zone	Bead	Hardened zone	Unaffected zone	Treated S.A.E 1050	Treated S.A.E. 3330
$^1/_8$	35	235–256	470–511	181–208	278–282	423–446	231–235	197[a]	232[a]
$^3/_{16}$	35	215–235	462–557	184–202	243–249	423–487	233–246	640[b]	514
$^5/_{16}$	35	199–208	385–426	177–187	249–280	420–466	245–251	...	...
$^5/_{32}$	200	243–246	365–487	182–191	280–288	398–446	227–235	682[c]	540
$^5/_{32}$	400	189–193	294–395	179–185	233–237	368–434	229–235	550	477
$^5/_{32}$	500	175–181	230–309	183–186	231–243	354–405	230–237	530	440
$^5/_{32}$	700	173–184	245–272	181–191	207–211	256–368	224–233	461	445
$^5/_{32}$	1000	146–162	197–229	181–186	187–198	245–339	227–238	321	302
$^5/_{32}$	1250	147–154	171–215	174–191	203–205	192–333	215–229	226	237

[a] Condition as received.
[b] Quenched from 1600 F (870 C).
[c] Tempering temperature corresponds to preheating temperature.

Frequently, it is expedient to weld steels with high hardening tendencies when strength properties of the weld are not required to approach those of the parent metal, but ductility is desired. An example is welding attachments to heat-treated steel where the attachments will not be subjected to high stresses. One of the most satisfactory methods is to use austenitic chromium-nickel 25/20 welding rod. The reason for using such a high alloy content is to insure an austenitic deposit, even though there is contamination from the parent metal. This alloy gives a very ductile deposit with tensile strength somewhat higher than can be secured with conventional mild-steel electrodes. Surprisingly, the hardness of the heat-affected zone of the parent metal is not as high as secured when mild-steel electrodes are used. However, it is desirable to stress-relief-anneal such welds if practicable. Even when using austenitic chromium-nickel-steel welding rods, preheating will result in lower weld hardness and there will be less danger of cracking.

Much stress has been placed on the effect carbon plays in promoting weld hardness. The maximum hardness obtainable is dependent almost entirely upon carbon content, but presence of alloys in steel and the amounts in which they are present do exert an influence upon the hardness numbers developed. In Fig. 12 is shown a comparison of the highest attainable hardness in steels of different carbon content with the weld hardness of carbon and 2 per cent nickel steel welded under different conditions.

EFFECT OF ADDING 2 PER CENT NICKEL ON WELD HARDNESS

When welding carbon steel at 5 in. per min, maximum weld hardening is far below the maximum which might be produced. Adding 2 per cent nickel increases the weld hardness but not a great deal above that secured with carbon steel. However, when 2 per cent nickel is added and the welding speed is increased from 5 in. to 12 in. per min, the hardness is raised nearly to the maximum obtainable. This indicates that under certain conditions the weld hardness may equal the maximum hardness obtainable in any steel, and from the broadest point of view it is apparent that steels with very low carbon permit greatest freedom in welding.

Alloy additions besides promoting higher weld hardness may also exert other influences which interfere with welding. Some of the complex low-alloy steels transform very slowly when cooled from temperatures above the critical range. If cooling exceeds a certain rate, transformation may occur as low as 500 F, Fig. 13. This means that expansion takes place when the steel is at a comparatively low temperature and in a rather rigid state. It is not surprising that cracks develop in welding such steels, even when weld hardness is not unusually high. If, however, these steels are subjected to controlled cooling as well as to preheating, transformation will occur at higher temperatures, and weld-hardness and cracking tendencies will be lowered.

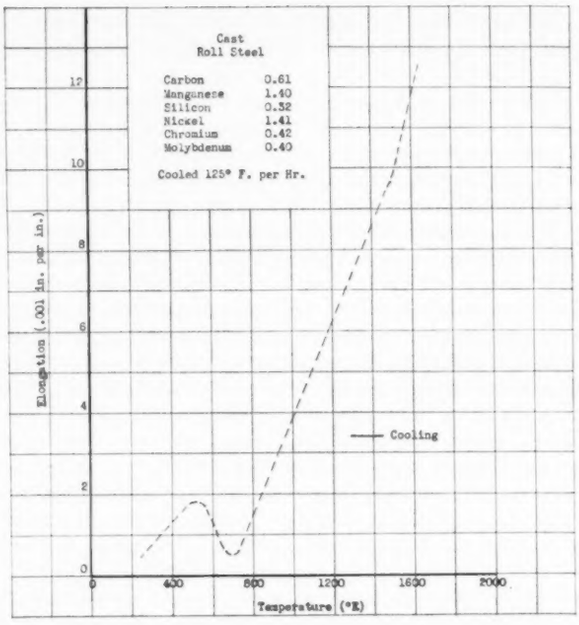

FIG. 13 DILATION CURVE, SHOWING DEPRESSED CRITICAL ON COOLING A COMPLEX ALLOY STEEL

BIBLIOGRAPHY

1 "Arc Welding of High-Carbon and Alloy Steels," by T. N. Armstrong, Trans. American Society for Metals, vol. 24, 1936, pp. 567–594.

2 "Weld Hardening of Carbon and Alloy Steels," by H. J. French and T. N. Armstrong, *Welding Journal*, vol. 18, Welding Research Supplement, 1939, pp. 339–347.

3 "The Effect of Alloying in Welding," by R. W. Emerson, *Welding Journal*, vol. 18, Welding Research Supplement, 1939, pp. 381–392.

4 "Metallurgical Changes at Welded Joints and the Weldability of Steels," by R. H. Aborn, *Welding Journal*, vol. 19, Welding Research Supplement, 1940, pp. 414–426.

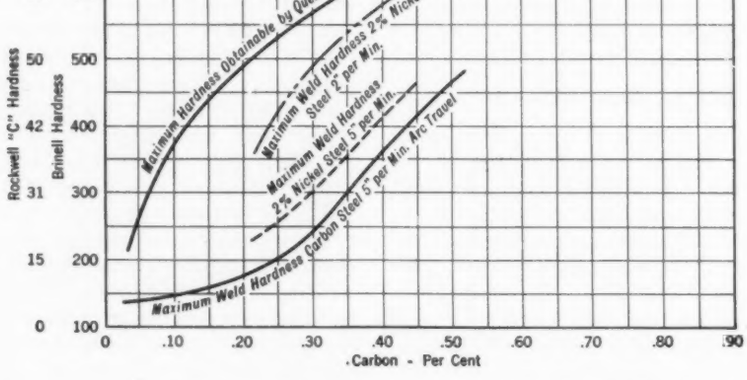
Rockwell "C" Hardness
Brinell Hardness
Maximum Hardness Obtainable by Quenching Carbon Steel
Maximum Weld Hardness 2% Nickel Steel 2" per Min.
Maximum Weld Hardness 2% Nickel Steel 5" per Min.
Maximum Weld Hardness Carbon Steel 5" per Min. Arc Travel
Carbon - Per Cent

FIG. 12 MAXIMUM WELD HARDNESS OF CARBON AND NICKEL STEELS WELDED UNDER DIFFERENT CONDITIONS, COMPARED TO MAXIMUM HARDNESS OBTAINABLE BY RAPID COOLING

COLLOIDAL FUEL

The Technical Problems Involved in Its Economic Use

By J. E. HEDRICK

DEPARTMENT OF CHEMICAL ENGINEERING, KANSAS STATE COLLEGE, MANHATTAN, KANSAS

IN 1879 (6)[1] it was proposed that oil be mixed with pulverized coal in order to get a fuel cheaper than oil but having many of its advantages. The work of Bates (1) in 1918 was the first important attempt at commercial utilization. An effort was made then to develop colloidal fuel for use in submarines. After the first World War this work was dropped. During the last decade efforts in this direction have been renewed in Europe, but there has been almost no consideration of this fuel in the United States. Reports of the work already done are sketchy and cover a limited number of tests. The review by Manning and Taylor (4), however, is a most complete account of previous research.

Presumably the favorable features of colloidal fuel might be listed as follows:

1 It may be cheaper than oil
2 It may be handled like oil in pipes and pumps
3 Its burning efficiency should equal or exceed that of oil
4 It may enable better utilization of storage space
5 It may permit conservation of our petroleum, or at least release more of it for more profitable markets
6 Its use would eliminate the danger of spontaneous combustion now present in coal storage
7 The ash and moisture content would be less than that of the coal and the heat value on a volume basis higher than for either oil or coal
8 Its use should permit better utilization of solid fuels such as low-rank bituminous, lignite, and cannel coals.

The most promising uses for colloidal fuel would naturally be those in which advantage could be taken of one or more of the features just mentioned. Outstanding examples are railroad, Diesel, and marine fuels, and in stationary power plants now using pulverized coal. It seems probable too that these oil-coal mixtures may have other important commercial uses than as fuel. Their use as a chemical raw material shows definite promise. The development of such a fuel does present technical problems, however, such as stability, flow through pipes, atomizing, grinding the coal, and mixing the coal and oil.

STABILITY

A practical requirement for the satisfactory use of oil-coal fuels is that the coal remain in suspension. The degree of stability is dependent on many variables, the most important of which are size of the coal particles, viscosity of the oil, density of the coal and oil, and the electrostatic charges on the particles. When settling occurs the coal packs tightly in the bottom of fuel tanks and other equipment. This settling does not follow Stokes's Law. The coal particles are of random size and shape, and they interfere with one another.

Stability may be produced by the addition of a third substance to the mixture. Many such addition agents can be used, but it is now recognized that there are three distinct types. These are emulsifiers, gel formers, and surface-active agents. With cracked residue fuel oils, because of their higher specific gravity and viscosity, no stabilizing agent is necessary unless the fuel is heated to temperatures higher than 120 F. Thus there is no stability problem in storage of the mixtures, but only in handling them where they must be heated before pumping and burning.

The preparation of ores by oil flotation is an excellent example of the use of an emulsion to produce a stable suspension. Experiments have been carried out on the stabilization of coal particles in oil using water-in-oil emulsions. The particles are held in suspension by being entrained at the water-oil interface. The use of emulsions, however, is entirely impracticable. They are easily broken by heating or mechanical agitation and they produce stability only with very small amounts of coal. Furthermore, the presence of the water would lower the heating value of the fuel.

Gels are produced by adding rubber, metallic soaps, and various fats and waxes to the oil. The function of these agents is to increase the viscosity. The trivalent aluminum soaps are

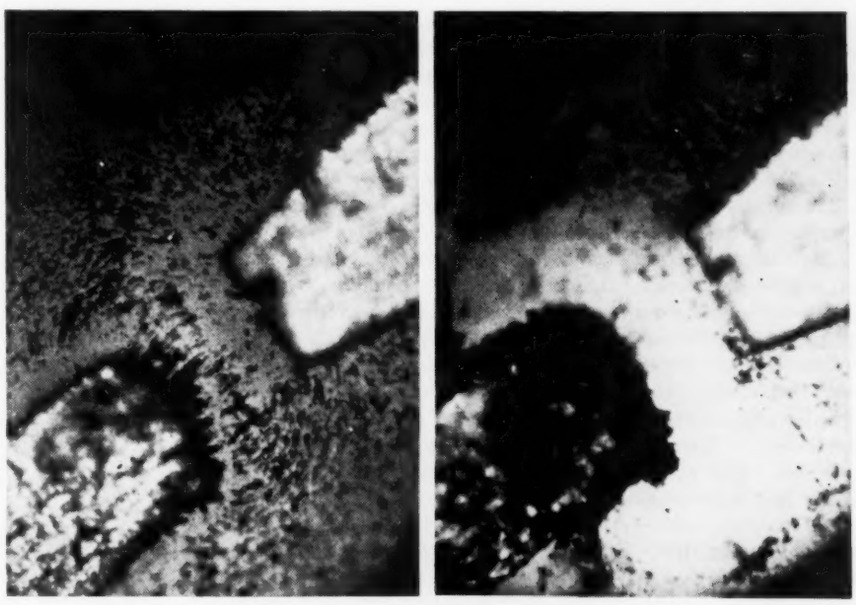

FIG. 1 ELECTROSTATIC CHARGE ON COAL PARTICLES IN OIL
(Left, no stabilizer; right, 0.2 per cent of surface-active agent.)

[1] Numbers in parentheses refer to Bibliography at end of paper.

Contributed by the Fuels Division and presented at the Semi-Annual Meeting, Kansas City, Mo., June 16–19, 1941, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

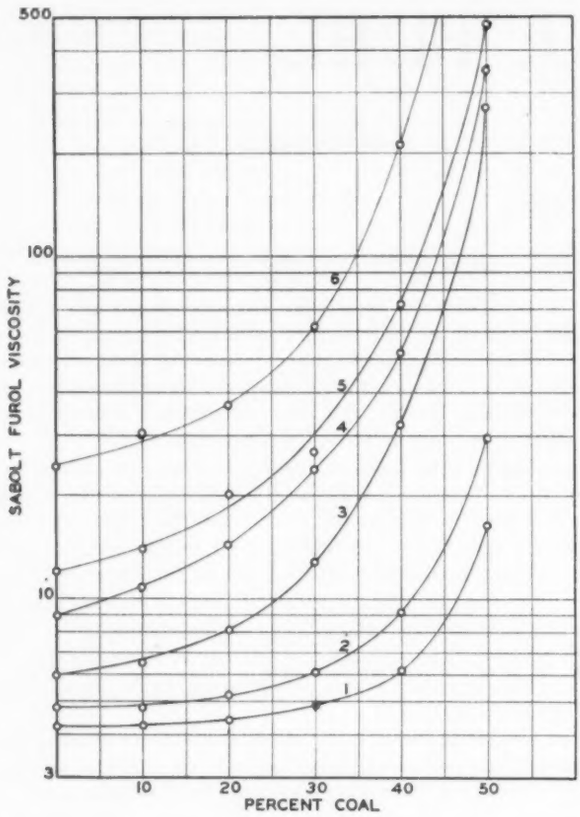

FIG. 2 EFFECT OF COAL CONCENTRATION ON VISCOSITY AT 210 F

more effective than the soaps of bivalent calcium, zinc, lead, and magnesium. From 1 to 5 per cent of these soaps, based on the weight of the finished fuel, must be added to prepare stable suspensions. The use of soaps would be expensive and the increase in viscosity would make pumping more difficult. The gels are sensitive to temperature change. Due to the "stringiness" they impart to the fuel, satisfactory atomizing at the burner tip is impossible.

When 0.05 to 0.2 per cent by weight of the condensation product of a fatty acid is added to an oil-coal mixture, a stable suspension is produced. This is an agent of the surface-active type. The mechanism of stabilization is not clearly understood, but it is known that a surface-active agent is selectively adsorbed on the surface of the coal particles and causes a lowering of the interfacial tension between the coal and the oil. Furthermore, it causes greater uniformity in the electrostatic charges on the coal particles.

The charges on coal particles are presumably caused by the friction during grinding. Since coal is not a homogeneous material, both positive and negative charges exist, even on different areas of the same coal particles. The oil is such a poor conductor that these charges are neutralized slowly. This means that the agglomeration of the particles with resultant settling proceeds slowly but definitely. The addition of the surface-active agent produces negative charges on all the particles. This effect is shown by comparison of the pictures of the two suspensions in Fig. 1.

Surface-active agents do not increase the viscosity of the suspensions appreciably. They are effective over a wide temperature range and they can be used with any petroleum fraction from gasoline to the heaviest fuel oil. A study of the economics of colloidal fuel (3) limits stabilizer cost to approximately 50 cents per ton. It is believed that this cost can be met with

TABLE 1 PHYSICAL PROPERTIES OF OILS USED IN EXPERIMENTAL WORK

	A.P.I. gravity, 60 F	Furol viscosity, 122 F
(1) Virgin gas oil	34.1	5.3[a]
(2) Cracked gas oil	29.5	7.3[a]
(3) Cracked residue fuel oil	8.5	18.5
(4) Cracked residue fuel oil	12.0	54.7
(5) Cracked residue fuel oil	10.9	112.7
(6) Cracked residue fuel oil	4.8	318.0

[a] Extrapolated values.

a surface-active material, because of the small amount required.

Experiment has shown that coals of a size larger than 75 per cent through 200 mesh are not satisfactory for making colloidal fuels. Larger sizes cannot be successfully stabilized. On the other hand, smaller sizes require much less stabilizer. Coal of about 98 per cent through 200 mesh seems to be most desirable. Finer coal would be too costly to grind. These results are based on two samples of washed bituminous coal of 1.32 and 1.26 specific gravity, respectively. Probably the results would be equally applicable with other similar coals.

FLOW AND ATOMIZING

No property of oil-coal mixtures is more important than the viscosity. The oils for the most part from which colloidal fuels can be made are viscous and the addition of coal to them increases the viscosity. This property is closely connected with the resistance of flow of these fuels in pipes and with the spraying from burner tips for efficient combustion.

Oil-coal mixtures were prepared using six oils of widely varying gravities and viscosities. The physical properties of these oils are shown in Table 1. The effect of the coal concentration (weight per cent) on the viscosity of these mixtures at 210 F is shown in Fig. 2. The steep slope of the curves at the higher coal concentrations should be emphasized. When a mixture contains more than 50 per cent coal it becomes a thick paste, which would not flow through pipes. There is a possibility, however, that such fuel pastes might be handled with a screw conveyer or some type of mechanical pusher. In general, the shape of these viscosity-concentration curves is the same at other temperatures.

Because of lack of information, a study has been made of the friction in pipes during the flow of these fuels. The equipment is shown diagrammatically in Fig. 3. The fuel was allowed to flow from a tank through a test line 22 ft long into a weighing tank. A constant head of 5 ft was maintained by means of an overflow pipe in the upper tank. A by-pass on the discharge end enabled the fuel to be recirculated and the overflow was also

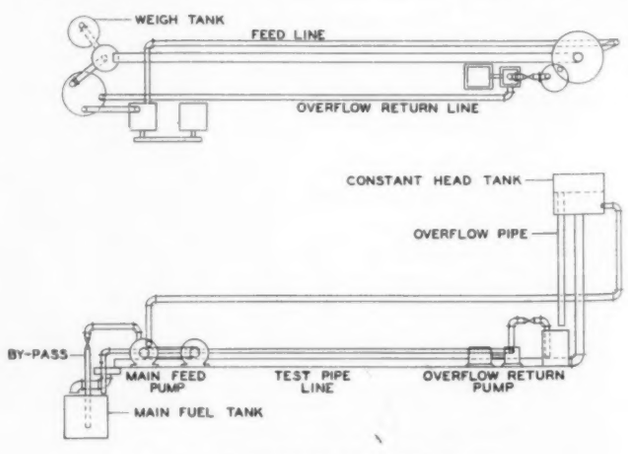

FIG. 3 DIAGRAM OF FLOW EQUIPMENT

pumped back. Test lines from $\frac{1}{2}$ in. to 3 in. could be used interchangeably. Electric heaters controlled by adjustable thermostats could maintain any temperature substantially constant over the range 80–200 F. The oil used for these flow tests was a cracked residue having a viscosity of 203 Furol seconds at 122 F. Both coal concentration and temperatures were varied.

The flow of colloidal fuels through pipes is well within the viscous range. Seldom will Reynolds' numbers be as high as 500. Curves showing the effect of temperature on the velocity in a 1-in. pipe are plotted in Fig. 4. Such curves are of considerable value in determining the temperature to which a fuel must be heated in order to get the required flow to the burner. Similar data for other pipe sizes are not yet complete.

This flow follows the Hagen-Poiseuille equation closely at low coal concentrations. There is some divergence with amounts of coal greater than 30 per cent, but the equation is sufficiently accurate for most calculations. The deviation results from the abnormal increase in the apparent viscosity. The particles tend to get in each others way and there is probably greater deformation of the protective barriers around individual particles as either concentration or velocity increases. Viscosities were determined with the Saybolt apparatus using Furol or Universal tips.

The maximum viscosity for satisfactory atomizing of fuel oil at the burner tip is approximately 40 Furol sec (5). On the basis of experimental tests it is concluded that the figure for colloidal fuels would be nearly the same. With a great many oil-coal mixtures this viscosity would be reached automatically due to the temperature rise caused by the atomizing steam and radiation from the firebox. With others, preheating in the fuel tanks would be necessary.

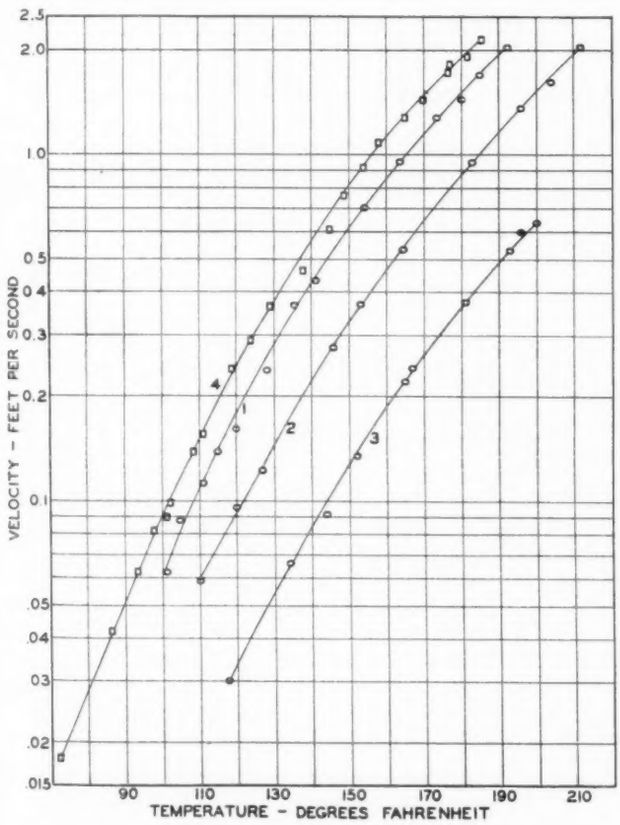

FIG. 4 EFFECT OF TEMPERATURE ON FLOW OF FUELS THROUGH 1-IN. PIPE

(Curve 1, 10 per cent coal; curve 2, 20 per cent coal; curve 3, 30 per cent coal; curve 4, fuel oil.)

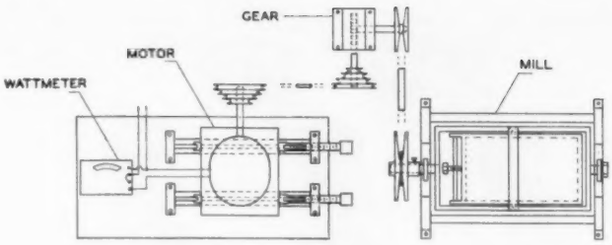

FIG. 5 VARIABLE-SPEED MILL FOR BALL-MILL GRINDING

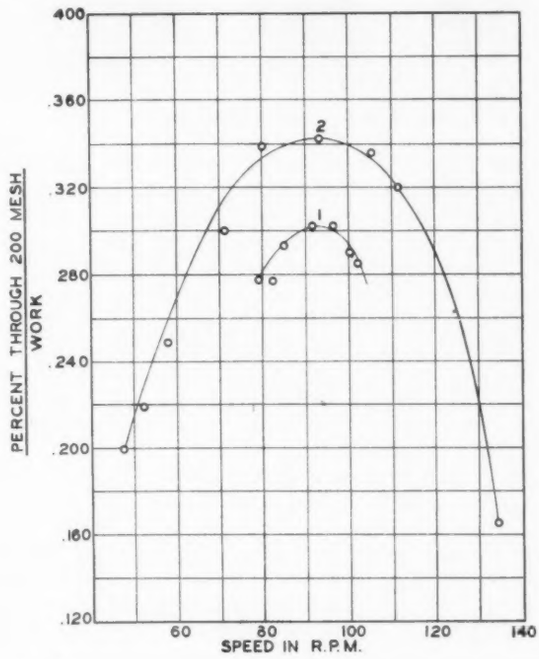

FIG. 6 EFFECT OF MILL SPEED ON GRINDING EFFICIENCY

GRINDING AND MIXING

The cost of grinding the coal is one of the most important considerations in the economics of colloidal fuel. This cost is a function of so many variables that it is difficult to predict what it would be for a given operation. Roller mills and ball mills are the types most commonly used for pulverized-coal burners. The choice of mill probably lies between the two.

In this work, studies have so far been confined to ball-mill grinding. The mill was that used for the determination of A.S.T.M. ball-mill grindability. It was driven by a $\frac{1}{2}$-hp motor and equipped with a system of variable-speed pulleys. By mounting the motor on an adjustable platform the speed of the mill could be closely controlled up to speeds of more than 150 revolutions per minute. Power requirement was measured by a suitable wattmeter and mill speed with a speed counter. The arrangement of this apparatus is shown in Fig. 5.

The speed of the mill has a pronounced effect on the grinding efficiency. Tests were conducted using a charge of 100 1-in. steel balls and 500 g of coal of size —10 and +200 mesh. The critical speed for the mill was 98 rpm. Critical speed is defined here as the speed at which a ball at the periphery of the mill will just be held in place by centrifugal force. The optimum speed for maximum power input was 92 rpm. Results for two coals are shown in Fig. 6. The optimum is therefore about 94 per cent of the critical. Both the optimum and the critical speeds vary with the mill diameter, but their relation to each other is not materially affected. An analysis of Fig. 6 leads to the conclusion that the distance the balls fall determines to a large

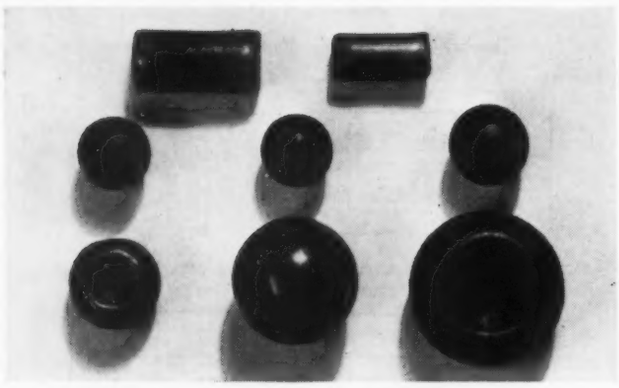

FIG. 7 BALLS AND RODS USED FOR COAL GRINDING

extent the grinding efficiency and therefore that the bulk of grinding is by impact rather than by attrition.

The size and shape of the grinding media materially affect the grinding efficiency. The media used in these tests are shown in Fig. 7. Data are far from sufficient to form a general theory, but several observations are interesting. For a required coal size of 90 per cent through 200 mesh, the $^1/_4 \times {}^3/_4$-in. rod gave the highest efficiency. For other sizes different media were more effective. In general, irregular shapes tend to prevent ball coatings which would otherwise lower efficiency. New balls are better than old or worn ones and hollow balls are less effective than solid ones.

No study has been made of grinding aids. Their function is to keep the grinding media free from coatings. Ball coating is influenced by the moisture content of the coal. When the moisture is 2 per cent or less there is no caking, but at 4 per cent moisture this becomes appreciable. Finer coal, of course, cakes more readily. In most cases the media and grinding conditions can be adjusted so as to prevent the formation of ball coatings.

Mixed charges of media influence the amount of product of a definite size. The results with various ball charges are shown in Fig. 8. These data emphasize that greater amounts of a smaller size are produced by using smaller balls. However, this is true only when the feed is proportionately fine. A definite size of grinding media grinds most efficiently within a certain size range. Thus, mixed charges are often a distinct advantage, each size operating most efficiently on a different size of coal.

A report on the ball-mill grinding of ores by Coghill and De Vaney (2) contains much information of use. The capacity varies as the 2.6 power of the diameter and nearly directly with the length. Increasing the circulating load increases the efficiency and capacity of a definite size. Lighter feeding is better and the load should be just sufficient to fill the interstices of the balls at rest.

Much work must yet be done on coal grinding. The information available is much too general for accurate use. Feed rates, mill shapes, and classification have hardly been investigated at all. An interesting possibility, also, is that of grinding the coal in oil. The coal might be ground first in a disk mill to 16 mesh or finer and then fed with the oil into a ball mill. Thus the fine grinding and mixing could be done in one operation. On the other hand, wet grinding would introduce complications in the way of fineness control, variations in dilution, and gumming up of the equipment.

A few cost figures for estimating purposes only are available. A ball mill or roller mill to produce 2–3 tons per hour of coal 90 per cent through 200 mesh would cost approximately $20,000. Power requirements vary from 10 to 35 kw per ton and maintenance and labor costs based on actual installations range from 3 to 10 cents per ton. That these figures are indefinite is at once apparent.

No data are available on mixing oil and pulverized coal. Laboratory mixing of small samples has indicated that effective mixing would be difficult since the materials are so viscous. It seems likely that mixing might be done more economically by heating the fuel to about 200 F to lower its viscosity. Sufficient consideration of this operation has been published elsewhere (3).

CONCLUSIONS

It is believed that the results of this work are sufficient to establish its commercial possibilities. The search for better and cheaper ways to produce stability must be continued. Much work still needs to be done on burning and atomizing and the investigation of grinding and mixing has hardly more than begun.

BIBLIOGRAPHY

1 "Colloidal Fuel," by L. W. Bates, pamphlet privately printed, 1918.

2 "Particle Size Reduction and Separation," by W. H. Coghill and F. D. De Vaney, Transactions of the American Institute of Chemical Engineers, 1938, vol. 34, pp. 113–129.

3 "Can Oil-Coal Mixtures Be Economically Developed," by J. E. Hedrick, *Coal Age*, 1940, vol. 45, no. 12, p. 65.

4 "Colloidal Fuel," by A. B. Manning and R. A. A. Taylor, Transactions of the Institution of Chemical Engineers, 1936, vol. 14, pp. 44–59.

5 Private communication from C. F. McClure.

6 "Liquid Fuels," by H. M. Munsell and H. R. Smith, U. S. Pat. 219,181, Sept. 2, 1879.

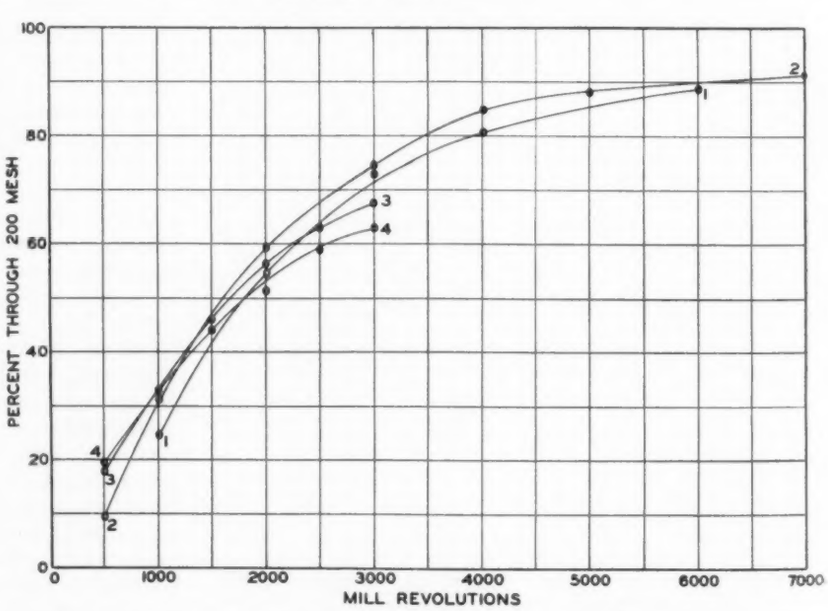

FIG. 8 THE EFFECT OF DIFFERENT BALL CHARGES ON GRINDING EFFICIENCY (COAL —10, +200)

(Curve 1, 1000 g coal, 30 lb $^9/_{16}$-in. steel balls; curve 2, 800 g coal, 22 lb $^9/_{16}$-in. steel balls; curve 3, 800 g coal, 11 lb 1-in. steel balls and 11 lb $^9/_{16}$-in. steel balls; curve 4, 800 g coal, 16 lb 1-in. steel balls and 6 lb $^9/_{16}$-in. steel balls.)

AIR CONDITIONING *in the* FLOUR MILL

By GEORGE M. SEBREE

PRESIDENT, WESTERN AIR CONDITIONING CORPORATION, OMAHA, NEB.

FLOUR milling, in simplest terms, is a process of alternately grinding and sifting wheat. The wheat itself has received a great deal of attention and interest from the miller ever since the first measure of wheat was ground, and its products baked. This must have taken place several thousand years ago. But only recently, during the last quarter century, has the great effect of air on, and in, the milling process, received much attention.

Air, and particularly the moisture content of this air, is important in milling because of the very hygroscopic nature of the wheat berry and its products. This characteristic affects the entire operation of the mill. Most important of all, it affects the amount of marketable finished products that can be recovered from any given quantity of the raw material—wheat—that enters the mill.

The cleanliness and temperature of the air in the mill are also important. Flour is a food. It is literally finer than dust, and atmospheric dust will mix with it all too readily if given a chance to do so. Temperature is important, both from a standpoint of the operator's comfort, and because of the fact that it can affect the adjustment of the various milling machines and the rate of flow of the mill stocks through the machines and from one machine to the next.

To control humidity, temperature, and air cleanliness in the mill, air-conditioning equipment has been installed in three modern flour mills built in the Middle West during the last five or six years. These three mills are all about the same size and daily capacity. There are some differences in them, of course, and therefore this paper will describe the system in the new plant of the Tri-State Milling Co., built at Rapid City, S. D., in 1938.

TRI-STATE MILL DESCRIBED

The Tri-State mill has six floors, is 37 × 80 ft in plan, with a total height of 80 ft. It is almost windowless, outside light being admitted through glass-brick panels, and the roof is insulated with rigid insulation 2 in. thick. The walls are brick and tile, plastered inside, and do not transmit heat readily. In a building of this type, air conditioning has a real chance to go to work and show what it can do.

The Tri-State mill has a nominal capacity of 600 bbl of flour per day. The first floor of the mill building is used for packing and storage and the second floor for cereal milling. On the third floor are the roller mills. This is the heart of the milling process, and it is here that the effect of the air-conditioning system is concentrated. The fourth floor is used for general purposes, and the air-conditioning equipment is located on this floor. The fifth floor contains purifiers and sifters, and the sixth floor is used for cyclone dust collectors, conveyers, blowers, and air ducts.

REASONS FOR AIR CONDITIONING EXPLAINED

The dollars-and-cents reason for air conditioning in a flour mill is the saving of shrinkage in mill stocks from needless evaporation. Under conditions which are not at all unusual, this saving may be as much as 1 per cent of the entire output. When we remember that in a mill of 600 bbl per day capacity this saving would mean six barrels of flour with a wholesale value of around $5 per barrel, it is plain that this saving is worth while.

The best general-purpose flour has a moisture content between 13.5 and 14 per cent by weight. The wheat will enter the mill at any moisture content from 16 down to 12 or even 10 per cent. Deficiencies of moisture content in the wheat can be overcome to some extent by "tempering," or mixing with water, before the wheat enters the first break roll. But from that point on, in the average unconditioned mill, the moisture content of the mill stock is strictly a matter of chance, depending on what the outside weather happens to be.

There is a limit to the amount of moisture that can be added to the wheat by tempering. If too much water is used, the wheat will "mush" on the rolls, and will go through the first sieves very slowly, if at all. There are no possibilities of adding water to the finished flour—the result would simply be dough. Storage of the finished flour in a room at high humidity does not offer much hope either. It would probably take weeks to raise moisture content of the flour uniformly, and few mills have space to store even their own production for more than a few days.

The principal fact about air conditioning in a flour mill is that mill stocks, the products of the wheat berry in smaller and smaller particles as they pass through the rolls and sieves, tend to lose moisture if given any opportunity to do so. In an unconditioned mill the low relative humidities that usually prevail will evaporate moisture from the stocks at any and every point in the mill. The point of greatest moisture loss however is where the stocks are in contact with the hot rolls themselves. Considerable power is required to drive these rolls, and some of this power is converted into heat. The rolls get hot and stay hot.

Evaporation could be stopped entirely, of course, if we maintained a high enough relative humidity in the mill. It would not be desirable to do this however, principally because with present roller-mill equipment there would be real trouble in holding roll temperatures down to even a reasonable point unless some evaporation were permitted. By taking into account the equilibrium relative humidities for various moisture contents of the finished products, and tempering the entering wheat to the proper point to permit the necessary amount of evaporation, the moisture content of the finished flour can be controlled with great exactness.

Without reciting the entire table of equilibrium moisture contents for various relative humidities, it is sufficient to say that 60 per cent relative humidity equals the desired final moisture content of 13.7 per cent. The entering wheat is usually tempered to 15.7 per cent, to allow for 2 per cent evaporation. If the mill stocks were in contact with the air at 60 per cent relative humidity long enough, the resulting flour would be at 13.7

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per cent no matter what the entering moisture content of the wheat. However, the stocks are in the mill only 20 to 30 min; to make sure of positive results from the constant relative humidity in the mill, the wheat must be carefully tempered before it enters the mill.

MILL TEMPERATURE AND ITS MAINTENANCE

Closely connected with relative humidity, in flour mills as everywhere else, is temperature. The optimum temperature for flour milling would be 78 F the year round. In summer this calls for cooling. In winter some heating may be required. Note the word "may," because there is a source of heat in the mill, ready at hand, that may be used to do a large share of the necessary heating in winter. This is mechanical heat generated from the moving mill machinery. About 0.4 hp per bbl of daily capacity is required to drive the rolls, sifters, purifiers, and elevators, of the mill proper, and the separators and scourers in the wheat-cleaning department.

In a 600-bbl mill 600 × 0.4 × 2546 or 611,040 Btu per hr might be available as waste heat if it could be trapped and kept inside the building. Not all of it can be kept inside by any means, but enough of it can be salvaged to make a real saving in fuel required to heat the building.

As a general rule, the Tri-State mill will automatically stay at 78 F inside, without help from its own steam-heating plant, until the outside temperature has dropped to about 30 F. As a matter of fact, the fresh-air damper must always be ready to open as much as required to prevent overheating in winter. And the steam-heating plant as installed must be of ample size, because mills of this type are fumigated by heat. The heating system must have capacity to raise quickly the temperature inside the building to 145 F in all seasons of the year except the dead of winter. In regular operation, only a small part of the heating system's capacity need be used.

Air conditioning must start with the building structure. It does little good to produce desired temperatures and relative humidities inside if the building will not hold these conditions. Therefore, it is difficult to apply air conditioning to existing mills, since these are usually of reinforced-concrete-framework construction and have thin brick walls and large areas of single-thickness glass. It is almost safe to say that no one can afford to build a new mill without air conditioning and that it would hardly pay to make the necessary changes to the building structure to install air conditioning in most present mills.

From a heat-economy standpoint the average existing mill, in full operation and probably making good profits, presents a dismal picture. All of the machinery heat and most of the heat generated by the mill's own heating plant is steadily exhausted outdoors at the rate of a complete air change in the building every 8 or 10 min, by the mill's own air-handling equipment. And in winter, there is nothing to take its place but cold air from outside. Add to this the heat loss through the thin walls, and the large windows, and a heating problem really exists.

AIR-CONDITIONING CYCLE OF FLOUR MILL

In considering the actual cycle of operation of the air-conditioning equipment in the Tri-State mill, a good place to start is with the air exhausted by the milling machinery. This air amounts to about 7500 cfm, which is just half the total of 15,000 cfm handled by the air-conditioning system. Of the approximately 7500 cfm exhausted by the machinery, about 40 per cent comes from the rolls. This air is usually 12 to 15 deg warmer than the air in the mill, having been heated by passing over the hot rolls. It is also heavily humidified from evaporation of the stock on the rolls. This is the air that, after three separate cleaning operations, is used to build up heat and humidity in the mill in winter. In summer, this roll air is usually exhausted outdoors, because cooling outside air to take its place makes less load than cooling and, to some extent, dehumidifying the roll exhaust air.

Most of the remaining 60 per cent of the air from the milling machinery comes from the purifiers. Each of these machines has a fan which lifts the lighter mill stocks by aspiration. Little heat is involved in the purifying process, but the air exhausted may have a slightly higher relative humidity than the air in the mill because of evaporation from the stocks passing through. This air is returned to the mill in winter, in summer and at other seasons of the year some of it may be automatically exhausted outside as required to maintain conditions in the mill.

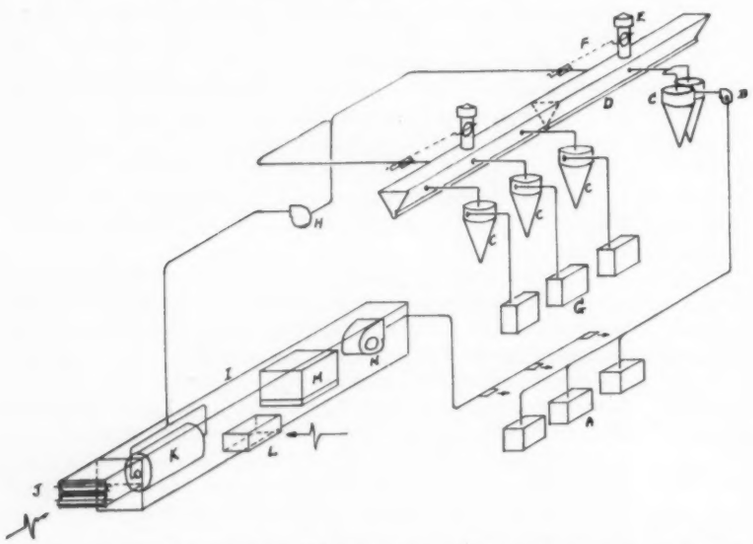


FIG. 1 SCHEMATIC LAYOUT OF 600-BBL FLOUR-MILL AIR-CONDITIONING SYSTEM

[*A*, line of roller mills on third floor; *B*, roll suction fan; *C*, cyclone dust collectors; *D*, air collector trunk on ceiling of top floor; *E*, exhaust ventilator through roof; *F*, roll return and exhaust dampers; *G*, line of purifiers on fifth floor; *H*, return-air suction fan on top floor; *I*, air-conditioning-equipment room on fourth floor; *J*, roll and purifier outside-air dampers; *K*, stocking-type dust collector; *L*, return-air opening to fourth floor, with heating coil and hand damper; *M*, two-stage air washer; *N*, main air-supply fan to discharge grilles near ceiling of third (roll) floor.]

As will be seen from the schematic layout of Fig. 1, air from both the rolls and the purifiers is first discharged into cyclone dust collectors, where the heavier and larger particles are collected, and the air cleaned to that extent. The air with the lighter and smaller particles of stock then passes to a collector trunk at the top of the mill. This trunk is triangular in shape, with steeply sloping sides, and with a screw conveyer at the bottom. The sections connected to the rolls and to the purifiers are separated by a partition. Because of reduction in velocity in this trunk additional particles settle out and are collected in the screw conveyer.

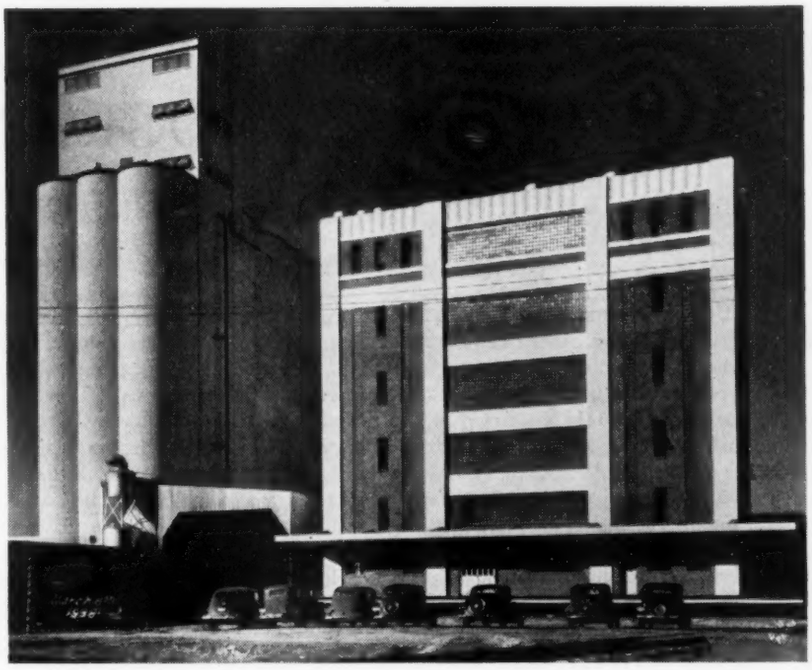
Each main chamber of the collecting trunk is connected to one or more ventilator heads through the mill roof. The ducts to these ventilators are fitted with a heavy steel-plate damper. A return duct is also brought out of the side of each section of the collecting trunk, and these return ducts also have steel-plate dampers. These dampers are connected to damper motors and are linked together so that, as the exhaust damper closes, the return

damper opens, and vice versa. The linkage is adjusted so that the exhaust damper never closes tightly. It is impossible to balance the air delivered by the machines and the air taken by the return fan to the last cubic foot, and an excess pressure or vacuum condition in the ducts has a bad effect on the performance of the purifiers. In addition to this, excess pressure in the ducts and spouts may cause dust to blow out into the mill through spout inspection plates.

Return ducts from the two sections of the collecting trunk are joined and brought to the suction side of the main return-air fan. This fan operates at constant speed and has ample capacity to handle all air exhausted into the collecting trunk by the milling machinery. The fan discharges into a duct which is brought down from the sixth to the fourth floor and which then divides and is brought into both ends of a stocking-type dust collector.

The stocking-type dust collector is located in the air-conditioning room. It consists of a large cloth filter, revolving slowly and stopping perhaps 40 times during each revolution. It is more or less self-cleaning, having an arrangement of rubber-tipped hammers which give several hard thumps to each row of stockings stopped momentarily in the top position. This top row of stockings is at that moment under suction, while all the other rows of stockings are under pressure, from the main return fan, of upward of 1 in. of water. The dust precipitated by this combination of thumping and suction is removed by a screw conveyer.

If the ventilator dampers are closed and the return dampers are open, about 7500 cfm of clean air will issue from the stocking-type dust collector. This is, in fact, the conditioned air that in winter maintains the mill at the temperature and humidity condition for which the control instruments are set. This applies, of course, if the outside temperature is between 65 and 30 F; if the outside temperature is below 30 F, it will be necessary to call on the mill's heating system for some help.



AIR-CONDITIONED TRI-STATE FLOUR MILL AT RAPID CITY, SOUTH DAKOTA

ARRANGEMENTS FOR HEATING

Additional heat is imparted to the air, when needed, as follows: The stocking-type dust collector and all the ductwork between it and the milling machinery can supply only half the air handled by the air-conditioning system. The remainder is brought directly into the air-conditioning room by a return-air opening to the fourth floor. In this opening is a finned-type heating coil, connected to the steam-heating system and with a modulating steam control valve. This steam valve is controlled by a thermostat set at 76 F. Exhaust dampers are set to close to minimum position when the temperature in the mill drops to 78 F, and if this temperature drops 2 F further, or to 76 F, the steam valve will start to open.

The roll suction exhaust and return dampers are controlled by a hygrostat, which also controls one section of 40 per cent of its total area of the fresh-air damper. If the humidity rises too high in the mill in winter, the roll air is momentarily exhausted outside. This usually brings the steam coil quickly into play, but humidity conditions restore themselves in a few minutes, and the whole thing is in balance with most of the roll air being returned to the mill. Both the purifier exhaust and return dampers are controlled by a thermostat which also controls the other section of 60 per cent of the area of the fresh-air damper.

THE AIR WASHER AND AIR AND TEMPERATURE CONTROLS

Between the stocking-type dust collector and the main fan is located a two-stage air washer which cools the air, and hence the mill, in summer. The first bank of sprays handles recirculated water only. The pump connected to this first bank is started and stopped by a thermostat in the mill. The second bank of sprays is connected to a well pump, delivering water at 50 F, which is the temperature of the ground water available at Rapid City, and at the rate of 100 gpm. This well pump is controlled by a hygrostat and starts whenever the humidity in the mill rises above instrument setting.

On the summer cycle, when the temperature of the mill starts to rise, the controls first exhaust all mill machinery air and a large volume of outside air enters the system. This may reduce the temperature sufficiently from outside air alone. If the temperature continues to rise, the recirculating pump starts, cooling the air by evaporation. If this results in too high humidity in the mill, the well pump starts. For conditions at Rapid City, in the Black Hills, cooling by evaporation with the first bank of sprays is all that is necessary to maintain proper temperature and humidity conditions during 90 per cent of the time in summer.

The fresh-air intake is located on the fourth floor, 50 ft above the ground. This is a naturally dust-free location, and while all air entering this intake is filtered, the filters have a gratifyingly long life. The main fan delivers the conditioned air to a duct on the roll floor, where it is distributed by adjustable grilles. All floors have gratings through them, and that part of the conditioned air that is needed is drawn to machines on other floors by the steady suction of the fans on these machines. Fifty per cent of the total air handled by the system again enters the milling machines having suction apparatus; the other fifty per cent may go back to the air conditioning room through the return air opening, and the cycle of the air is complete.

INDUSTRIAL RELATIONS IN AUTOBIOGRAPHY[1]

By DOUGLAS M. McGREGOR

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

ONCE in a blue moon there comes a book which deals with critical current issues in a manner that takes them out of the realm of controversy and allows the reader to appraise them quietly and objectively. Mary Gilson's recent book[2] does just this. It is written in autobiographical style, and it deals primarily with her own experiences in the field of industrial relations. Moreover, it is written with great charm, and the reader is carried along almost without effort.

Miss Gilson's career has been an exciting one and a rich one. After a childhood in Pittsburgh and an education at Wellesley, she found herself teaching in the Boston Trade School for Girls. From there she went to the Clothcraft Shops of the Joseph and Feiss Company where she was personnel director in fact if not in title for twelve years. During those years—she refers to them as the most exciting of her life—she was an active participant in the development of a program of industrial relations which even today would be considered unusually progressive. Her discussion of the problem of promotion and of the place of the foreman in industry is remarkably penetrating. Although she is somewhat critical of the Western Electric Hawthorne experiment, it is apparent that the personnel practices of the Joseph and Feiss Company in the second decade of the century were based upon an understanding of social relations in industry which is basically similar to the one which has emerged from the Hawthorne studies.

There is, however, in Miss Gilson's story the flavor of something else which has by no means been adequately expressed by the majority of writers on industrial relations. She is keenly aware of this basic fact (and it *is* a fact, not a mere philosophical opinion): We cannot hope to maintain a *political* democracy in America today unless we also develop an *industrial* democracy. These words will smack of radicalism to some readers, but the point is a simple one, and it is not radical. Industry is far and away the most important institution in our civilization. Some of the major satisfactions of life—both financial and nonfinancial—are associated with work. Not only that, but also the fact that the average man—whether worker or manager—spends a large portion of his adult waking life on the job, contributes to the importance of industry in the lives of most of us. We cannot conduct our national life in watertight compartments. If a man learns only the ways of autocracy on the job, if his most important satisfactions and a major share of his time are spent in an atmosphere where the leaders dictate and he is expected to obey, how shall we expect him to learn and appreciate the democratic way of life?

In the days of the town meeting, before industry assumed its present importance, nearly all of the important areas of life were subjects for mutual discussion and group decision along democratic lines. As political units became more complex and increased in size, it became less and less possible for the average individual to practice democracy except by the (to him) relatively meaningless process of going to the polls at infrequent intervals. There were few opportunities for him to learn of democracy by doing. With the growth of industry and of the large corporation, there came the necessity for more and more frequent obedience to rules laid down by the few who managed—rules the purposes of which the average worker rarely understood. His whole existence might be vitally affected by decisions made in meetings which he did not attend.

These things developed until, not so long ago, few workers had any experience at all of anything but purely political democracy. With the recent trend toward acceptance of the principles of collective bargaining, the worker has begun to have the opportunity to participate in democracy again, at least in certain areas. But even there, many major decisions are still considered to be the rights of management, and the worker is expected to accept them without question. Is it any wonder, in the light of these historical facts, that we have seen strife and misunderstanding and recrimination as some of the major consequences of the National Labor Relations Act? We have suddenly restored (in some measure) the rights of democracy to those who have long since forgotten what democracy really means. They have little or no realization of the responsibilities which necessarily accompany rights.

Miss Gilson points out again and again in her book the opportunities that are present in the industrial situation for the operation of a live and meaningful democracy. The experiences of the Joseph and Feiss Company twenty-five years ago demonstrate effectively that workers will not abuse their privileges if they have the opportunity to learn what those privileges mean. Miss Gilson demonstrates beyond a doubt that the past can be a prologue to a really effective future democracy only to the extent that we cease to treat those phases of life in which property rights are involved as though they were somehow exempted from the democratic rules which apply on the purely political level. Unless such unrestricted democracy becomes our accepted practice, we shall end inevitably with a dictatorship as restrictive as that of Nazism.

The first World War interrupted Miss Gilson's work for the Joseph and Feiss Company, and she became for a time a consultant who devoted her energies to setting up more adequate personnel procedures in various defense plants. Following the war she combined some of this consulting work with her earlier job. She presents a penetrating analysis of the textile industry, particularly in her not altogether unsympathetic discussion of the paternalistic practices of Southern mills. She indites paternalism for the subservience to which it leads, but at the same time she recognizes that effective democracy cannot be practiced until people have been taught what it implies. Paternalism could and did thrive in the South because the workers had no knowledge of anything else.

With the crisis of the early twenties, Miss Gilson returned to school. She went to Columbia to obtain a Ph.D. Once more she presents a keen criticism of some of the flaws in our system of higher education. With her rich practical background she

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[2] "What's Past Is Prologue: Reflections on My Industrial Experience," by Mary Barnett Gilson. Harper & Brothers, New York, N. Y., 1940, $3.

could not help but be critical of the abstract theories of the academicians. She points clearly to the need, which is only now being realized, for adapting graduate training in the social sciences to the actual problems of the present.

She never completed her graduate work. She left to become a member of the group from Industrial Relations Counselors who studied industrial relations in the sugar plantations of Hawaii in 1925. Then, still under the auspices of this organization, she studied unemployment compensation here and abroad. Finally, somewhat disillusioned by what she considered biases of the people for whom she was working, she went to the University of Chicago to join the staff of the economics department.

With one exception, there is very little of the reformer to be found in this book. The exception is the question of women's rights. Miss Gilson is an ardent champion of her sex, and of its capability. She makes frequent demands that women be treated in industry on a basis of equality with men. If her own record is an indication of what a woman can accomplish in the field of industrial relations, this reviewer for one is more than ready to grant the force of her argument. Nevertheless, the reader soon comes to expect at least one comment on this subject every few pages. And his expectations are rarely incorrect.

The outstanding feature of this book, perhaps, is its flavor. Written informally, and with a calm objectivity which creates respect, it carries the reader along with the feeling that he is living vicariously Miss Gilson's own experiences. More than that, because it is tied to earth, because she writes vividly of actual situations, of real people, and of problems that are ever-present, her discussion carries conviction.

There is much meat in this autobiography for the man (out of deference to Miss Gilson, one feels inclined to add "or woman!") who is in a managerial position in industry. The book is full of shrewd psychological insights into everyday problems of management. Her actual suggestions are few, but many are implied in her diagnosis of the situations through which she has lived.

There are others engaged in work in industrial relations who could write vividly and helpfully of their experiences. It is to be hoped that Miss Gilson's book will be but the first of a series which will give us a factual picture—colored of course by the author's predilections—of industrial relations in the everyday sense. We are all of us too much impressed by the examples of industrial strife of which we read in the press. We tend too easily to accept these as representative, and to forget that successful industrial-relations practices seldom reach the newspapers.

A Suggested Design for Mechanical Engineering Curricula

(Continued from page 584)

en attempt to indicate that mechanical engineering is in its essence the economical selection of alternatives.

EXTENT OF THE CURRICULUM

An examination of Fig. 1 might lead one to the conclusion that a mechanical-engineering curriculum covering the field as represented would go far beyond the four years now allotted to undergraduate work. Perhaps it will; but it is earnestly believed that a careful study of proper correlation of instruction will result in reducing duplication of instruction and overemphasis on certain material, thus providing adequate time within four years.

To accomplish the purpose of such a program, it is recognized that selection of students has a bearing on its success. It will only be successful when and if mechanical engineering is recognized as basically rational and not empirical. To accept this viewpoint a stricter selection of aspirants is considered essential, and aptitudes for mathematics and the physical sciences may well be considered as the best criterion for selection.

The object of this article, then, is to suggest that mechanical engineering consists of a number of engineering practices synthesized into many applied fields; that these practices are for the most part rational; and that none may be considered as limited to any one specialization or division. A further object is to suggest that the teachers of mechanical engineering accept a principle or formula for education to their profession and that mechanical-engineering curricula be built around it.

It is recognized that the specific suggestions contained in the article are perhaps inadequate for the purpose of establishing that principle. They are offered with a sense of inadequacy but with the hope that teachers and practicing engineers will jointly provide a guide that will aid in maintaining a common objective for all.

This guide should not be designed or promulgated in order to regiment institutions in their educational program, but should establish for mechanical engineering a "Principia" such as that which, presented by Dr. Little, guides chemical engineers in their educational processes.

TRAINING INSTRUCTOR SUPERVISES CLASS OF APPRENTICE WELDERS AT AMBRIDGE, PA., PLANT OF AMERICAN BRIDGE COMPANY, U. S. STEEL CORPORATION SUBSIDIARY

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Fire and Burglar Alarms

SCHWEIZERISCHE BAUZEITUNG

AN English abstract of a paper "Cerberus Alarm—und Meldeanlagen," by W. Jaeger, originally published in *Schweizerische Bauzeitung*, Nov. 30, 1940, appears in *The Engineers' Digest* of March, 1941. The article gives a description of a new fire alarm and a new burglar alarm.

FIRE ALARM

A new fire alarm has been developed, which depends neither on the temperature of the air nor on the presence of smoke, but works as soon as there is a smell of burning. The instrument functions by detecting the presence in the air of complexes of molecules which are produced by combustion. A potential relay is used to actuate the alarm.

In combustion, parts of the burning body (salts) are vaporized and become charged with electricity (ions). These charged particles give rise to the formation of complexes (Langevin complexes) of some millions of molecules. An arrangement according to Fig. 1 can be used in order to ascer-

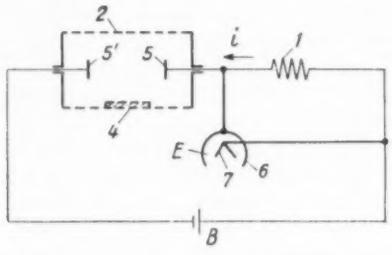


FIG. 1 DIAGRAM OF CONNECTIONS

tain if the air contains such complexes. The air to be tested is passed through the ionization chamber (2) and becomes ionized by the α particles emitted by the radioactive matter (4). Some molecules are split into electropositive and electronegative ions. The positive ions are attracted by the electrode (5'), the negative by the electrode (5), where they discharge. This causes a current to flow through the resistance (1). The voltage at its ends is measured with the electrometer (E) by the motion of its vanes. It has been found that a large increase of current occurs when the air in the ionization chamber contains flame gases or smoke, or when the air is only taken from near a burning or a glowing body. Such increases of the current occur even if the air does not contain any visible smoke. It is stated that changes of the chemical composition of the air have not so great an influence on the behavior of the apparatus.

Fig. 2 shows the construction of the instrument. The heavy lines indicate glass, and the covering, indicated by the outside dotted lines, is perforated metal which allows the room air to enter and leave the ionization chamber by diffusion and convection. In the ionization chamber (2) the air is ionized by the radioactive film (4) which is protected by a metallic coating (5). The resistance (1) of Fig. 1 is replaced by a closed ionization chamber, which contains the radioactive layer (3). When the electrometer vanes (7) become charged and open, they initiate a gaseous discharge between the contact electrode (8) and the movable electrode (7). The insulating coating (9) serves to prevent surface leakage. Its resistance is of the order of 10^{15} ohms. A heating coil is embedded in this coating which with the expenditure of less than 0.1 watt of energy prevents condensation of moisture and leakage.

The new fire alarm is said to be so sensitive that it functions even at the smallest fire. A little smoldering cotton waste, which produces only smoke, but no flame, or an ounce of burning wood wool, or some pieces of newspaper, which burn without producing smoke, cause the alarm to be given at once in a medium-sized room. Generally, the sensitivity is adjusted so that no signal is sounded by the smoke of a few cigarettes or a cigar.

BURGLAR ALARM

The burglar alarm has to function at any attempt of burglary, i.e., it has to give a signal when windows or doors are opened by force. The shocks produced propagate as vibrations through matter, and through the air as sound. If the disturbance is close at hand it will be rich in high-frequency components which are not transmitted as far as those of lower frequency. Thus the vibration from a step in a room has high-frequency components that are missing from the disturbance created by a train outside, although the amplitude of the latter may be greater.

Now the high-frequency vibrations as produced by the step

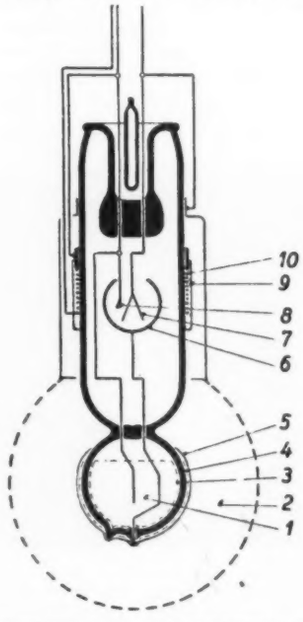


FIG. 2 DIAGRAMMATIC SECTIONAL DRAWING OF A FIRE ALARM

have a higher maximum acceleration than the low-frequency vibrations transmitted by the train or other similar shock. This difference is independent of the amplitudes of the vibrations. A burglar alarm, which has to function in response to disturbances originating in its neighborhood, has to be constructed so that it responds to the maximum acceleration of the vibrations, and not to their amplitude.

The new type of alarm, as shown by Figs. 3*a* and 3*b*, fulfills

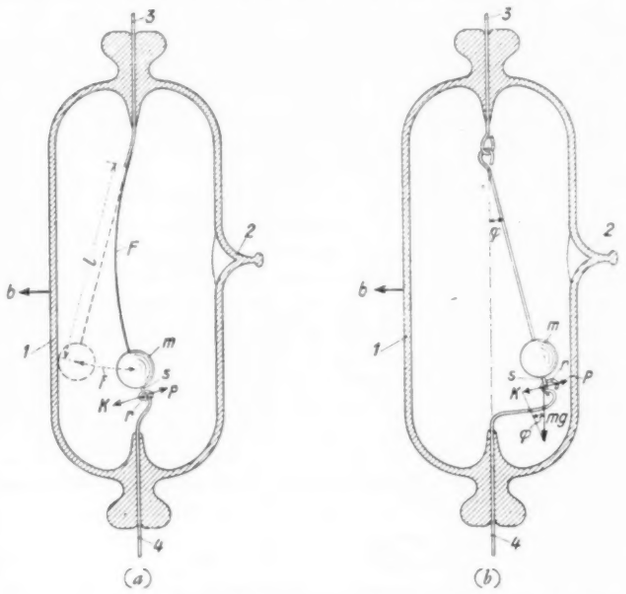


FIG. 3 DIAGRAMMATIC DRAWINGS OF ACCELERATION CONTACTS, SPRING AND PENDULUM TYPES

this condition. An acceleration of the apparatus in the direction of the arrow, which exceeds a certain limit—this limit depends on the mass of the little sphere (*m*) and other details of the apparatus—will have the effect of opening the contact between *s* and *r* and interrupting the circuit between (3) and (4).

The contact (*r*) is a wire ring into which the pin (*s*) projects; thus a vibration of the requisite acceleration causes the pin momentarily to break contact with the inside of the ring. This interruption initiates the signal. In order to secure a reliable contact, even with very little pressure between the contacting points, the apparatus is sealed in a glass vessel. By using a suitable gas for filling the vessel and the correct special metal for the contacts, highest sensitivity is obtained, and sticking of the contacts does not occur.

The original publication deals in detail with the interesting molecular phenomena, on which the behavior of the contacts depends. It is possible to give the alarm the right range of sensitivity for the service intended. Instruments which have to guard windows or doors have to respond to accelerations of 500 to 1000 cm per sec^2, whereas for protecting rooms against unauthorized persons an acceleration of 50 to 100 cm per sec^2 must release the alarm.

Instrument Bearings

MINING AND METALLURGY

IN AN article, "Precious and Semiprecious Stones," in the June, 1941, issue of *Mining and Metallurgy*, Sydney H. Ball has some timely comments on instrument bearings.

Diamonds, rubies, sapphires, synthetic sapphires, garnets, chrysoberyl, spinels, zircons, topazes, rock crystal, and agates, says Mr. Ball, are made into watch and chronometer jewels, and bearings for meters and other scientific instruments. They are also used in timing instruments, such as mechanical fuses for bombs, switches, and microgears. To be satisfactory the raw material must be hard to withstand the continual wear of steel axles, and be tough enough not to break if subjected to unusual strain. The gem stones used are usually cloudy or otherwise unsuitable for jewelry. The diamond, although superior to other gems, is not widely used due to two cost factors, that of the rough stone and the time and labor expended in shaping this the hardest of all substances.

Garnet and even rock crystal are used to a limited extent in the cheaper watches and instruments, and agate is used for certain large instrument bearings. Ruby and sapphire are now the principal materials for watch and meter and other instrument bearings, due to their hardness and relative facility of fashioning. Sapphires are preferred to rubies by most manufacturers but others claim they are more brittle. Formerly Australian stones were mainly used, then the Montana stones, and still later synthetic rubies and sapphires, which are cheaper than the natural stone. The chief synthetic corundum plants are in Germany, Switzerland, and France, with an output of from 750,000 to 1,000,000 carats a day (50 to 75 tons per year). American stocks of synthetic corundum are small and due to the war synthetic corundum imports are negligible. There is, however, in this country a small reserve of small Burmese rubies suitable for watch jewels. We may eventually be required not only to return to the use of higher-priced Montana sapphire but also train our own artisans to cut watch jewels and other bearings. We cut a few watch and bearing jewels in this country and since the war cutting facilities have been somewhat increased. Perhaps from 125 to 150 artisans are employed, a number sufficient to cut but a small fraction of the country's needs. The training of more artisans in this field would appear essential to our defense program. Also, it is probable that the Montana mines if vigorously exploited could furnish enough sapphire for our country's needs for at least a few years. In 1937, these mines produced almost 1$^1/_2$ tons of sapphire, although in 1938 and 1939 the production is understood to have been but about one third that amount. The price at the time was about one cent a carat or somewhat less. The other alternative would be to start a synthetic-corundum industry in this country; this would require time and men experienced in work unknown in America and a unit which probably could not compete with European plants if the war stopped.

Some twenty years ago, American watch companies cut their own jewels, the Waltham Watch Co. having a particularly extensive plant. Cheap European labor, however, killed the industry and recently watch jewels have been made largely in Switzerland, although a few are made in France. In 1939, the United States imported 43,712,840 jewels for watches and instruments, worth $913,245 (average price per jewel, 2.1 cents). Shipments of watch jewels are still received regularly from Switzerland and imports into the United States for the complete year of 1940 were large (98,771,042 jewels worth $1,831,007, or 1.85 cents per jewel, double the 1939 total value).

A dependable timepiece requires seven jewels and, in instances, as many as 23 are used in a single watch. They are the points on which the pivots run and they must furnish hard bearings for the small, finely tempered pivots. The cost of the jewels in the average movement is small, certain of the jewels costing but 1$^1/_2$ cents apiece. For many bearings, garnet is satisfactory, although inclined to chip. Fashion demands the use of one of the corundum gems in the finer watches.

The stone is first shaped into "bolts" by diamond-dust-fed

circular saws. These are cut to the approximate size, ground to almost paper thinness, rounded as to contour, and finally pierced at the center with a mild-steel drill fed with olive oil and diamond dust. Redrilling and polishing may be required to make the jewel fit exactly the axle rotating on this bearing. This is done with a wire coated with the diamond-dust-impregnated oil. V-bearings and cup-bearings are also used.

Sapphire and ruby jewels serve as pivots and counterpivots used in electrometers. Such jewels are not pierced but are cut into "cup jewels." Jeweled bearings are also used for bomb fuses and in the instruments for combat airplanes and bombers. A modern Curtiss pursuit plane has at least 90 instruments, dials, knobs, etc., and many of these require jewel bearings. Navigation watches alone have 21-jewel movements.

Sapphire and ruby (largely artificial, in part natural) are also used as needle points for phonographs and dictating machines, as "windows" to observe the mechanical action within an automobile cylinder or as windows in combustion chambers, in the sound-registration and sound-reproduction industries, and as dies. Relatively little wire is now drawn through corundum dies but the lead of pencils, in a plastic state, is forced under pressure through the apertures of corundum dies. Such dies usually have three holes.

Surface Hardening by Induction

THE ELECTROCHEMICAL SOCIETY

HIGH-FREQUENCY induction heating as applied to localized surface hardening is described in a paper by H. B. Osborn, Jr., of the Tocco Division, Ohio Crankshaft Company, presented before the April, 1941, meeting of The Electrochemical Society (preprint 79–24).

According to Mr. Osborn induction hardening equipment permits the user to surface-harden only the requisite portion of almost any steel object and thus maintain the original ductility and strength; to harden articles of intricate design which cannot be feasibly treated in any other way; to eliminate usual expensive pretreatment such as copper plating and carburizing and costly subsequent straightening and cleaning operations; to cut down on material cost by having a wide selection of steels

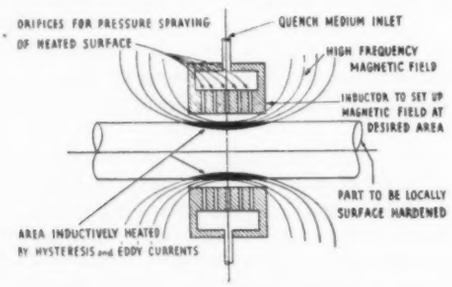

ORIFICES FOR PRESSURE SPRAYING OF HEATED SURFACE
QUENCH MEDIUM INLET
HIGH FREQUENCY MAGNETIC FIELD
INDUCTOR TO SET UP MAGNETIC FIELD AT DESIRED AREA
PART TO BE LOCALLY SURFACE HARDENED
AREA INDUCTIVELY HEATED BY HYSTERESIS and EDDY CURRENTS

FIG. 4 SCHEMATIC DIAGRAM OF AN INDUCTOR BLOCK AND MAGNETIC FIELD WHILE HEATING A BAR

from which to choose; and to harden a fully machined item without the necessity of any finishing operation.

Fig. 4 demonstrates the essential details of a heating and quenching unit. The heating is accomplished by the use of high-frequency currents. Specifically chosen frequencies from 2000 to 10,000 cycles per sec and upward of 100,000 cycles are being used extensively at the present time. Current of this nature, when caused to flow through an inductor, will produce a high-frequency magnetic field within the region of the inductor. When a magnetic material such as steel is placed within this field there is a dissipation of energy in the steel which produces heat. The molecules within the steel attempt to align themselves with the polarity of the field, and with this changing thousands of times per second, an enormous amount of internal molecular friction is developed as a result of the natural tendency for the steel to resist the changes. In this manner the electric energy is transformed, through the medium of friction, into heat. However, since another inherent characteristic phenomenon of high-frequency current is to concentrate on the surface of its conductor, only the surface layers become heated. This phenomenon, called skin effect, is a function of the frequency and, other things being equal, higher frequencies are effective at shallower depths. The frictional action producing the heat is called hysteresis and is obviously dependent upon the magnetic qualities of the steel. There is an additional source of heat due to eddy currents which occur as a result of the flux changes.

When the temperature of an inductively heated steel bar arrives at the critical, all heating due to hysteresis ceases and that due to eddy currents continues at a greatly reduced rate. Since the entire action goes on in the surface layers, only that portion is affected. The original core properties are maintained and the surface hardening is accomplished by quenching when complete carbide solution has been attained in the surface areas. Continued application of power causes an increase in depth of hardening, for as each layer of steel is brought to temperature the current density shifts to the layer beneath, which offers a lower resistance. It will at once be obvious that the selection of the proper frequency and control of power and heating time will make possible the fulfillment of any desired specifications of surface hardening.

From the metallurgical standpoint, carbide solution rates of less than a second, higher hardness than is produced by furnace treatment, and a nodular type of martensite are points of consideration that classify the metallurgy of induction hardening as "different." Further, surface decarburization and appreciable grain growth do not occur because of the short heating cycle.

Induction hardening produces a hardness which is maintained through 80 per cent of its depth and from there on toward the core, a gradual decrease through a transition zone to the original hardness of the steel as found in the core which has not been affected. The bond is thus ideal, eliminating any chance of spalling or checking.

All surface-hardening equipment consists of an inductor, quenching auxiliaries, suitable transformers and capacitors, automatic timing controls, and a high-frequency generator. In addition, provisions are made for handling of the parts intermittently or continuously depending upon production requirements.

The inductor may be a single turn of copper to fit the piece to be hardened or several turns of copper tubing shaped for the same purpose. Careful design is essential at this point to insure maximum efficiency. However, symmetrical inductors may be used to surface-harden unsymmetrical objects because of the natural tendency of the high-frequency current to follow the contour of the piece. The quenching medium is supplied through the inductor by means of orifices which are an integral part of it. The same timing device which controls the heating cycle operates an electric quench valve and controls the quenching cycle to the same degree of accuracy.

Automatic control and accuracy are keynotes in induction hardening from two standpoints: First, it is merely a matter of equipment design to have such precision involving exact locations of hardened areas (more than one area can be treated, simultaneously), and automatic control to within 0.1 sec. Second, this control makes each hardening operation and hardened object a facsimile of all those before and after it. Further,

total elimination of the human error avoids the usual variations and mistakes so characteristic of manual control.

Large converters of the generator type are in everyday use for 2000, 3000, and 10,000 cycles at capacities up to 1000 kw. Smaller 7.5 to 30-kw units of the spark-gap-oscillator type are used at frequencies upward of 100,000 cycles. Extremely high frequencies at low power are available from tube oscillators but not much of commercial importance has been done with such units for heat-treating or hardening.

In addition to the selective surface hardening of steels, there have been other applications of induction heating of rather a unique nature. Hardening a piece of steel and brazing to copper and other metals may be done simultaneously. A small section of a previously hardened object can be drawn or softened to a condition possessing ready machinability. Heating for forging and upsetting has been found to be a particularly satisfactory use for induction heating. The speed with which this may be accomplished has made it readily adaptable to the high production requirements of forming equipment, and scale problems are reduced to a minimum. The corresponding increase in die life is of extreme importance. Tip annealing of brass cartridge shells at the rate of 100,000 per hr is provided with a single induction-heating unit. [See page 566 of the July issue for note on "Bibliography on Induction Heat-Treatment"—EDITOR.]

Motor Vehicles and Static

ELECTRICAL ENGINEERING

IN AN article in *Electrical Engineering* for May, 1941, Robin Beach, professor of electrical engineering and head of department, Polytechnic Institute of Brooklyn, reports on a study of the fundamental elements of static electricity on rubber-tired vehicles which is intended to provide a basis for developing methods of control.

The seat of the generation of electric charges that constitute the electrification of a rubber-tired vehicle is at the area of contact between the tires and the roadway. The process of electrification is identical with the well-known ones of charging ourselves by scuffing on a woolen rug, or of charging a vulcanite rod by rubbing it with a piece of fur.

This process of electrification is that known as "contact difference of potential." It is a most interesting phenomenon about which much yet remains to be learned. If two metals are placed tightly in contact, a redistribution of so-called "free" electrons takes place within them, and therefore a difference of potential is established across their boundary, which is the contact difference of potential. The substance which gains electrons becomes negatively charged and the other, having lost electrons, becomes positively charged. The boundaries of substances are normally bombarded by the free electrons in their attempt to escape, a condition that is similar to the boundary restraint imposed by surface tension against the escape of atoms of a fluid. The flow of the electrons between metals in contact occurs from that substance for which the lesser force acts at its boundary contacts to impede their escape.

These contact voltages for metals have been found to range from a few tenths of a volt to about one volt. The surfaces that are firmly in contact are actually separated by distances of the order of molecular proportions, approximately 1/100,000,000 in. or less. These orders of magnitudes are important since they determine the values of voltages found in static electrification. As the two metals are now separated, the stretching of the lines of force between the positive charges on one and the negative charges on the other causes the voltage between them to increase, thereby tending to reunite these separated charges. Being free to move through the conductive metal to the location of least potential difference, which occurs at the last point of remaining contact between the surfaces, the two metals upon separation thus completely lose their charges and hence all evidence of former contact voltage.

In nonconductors of electricity, such as rubber tires, the electrons are unable to move about freely as in the metals. Since the charges are constrained to remain in fixed positions for nonconducting materials, each substance retains about as many charges as were imparted to it by the contacts, and the

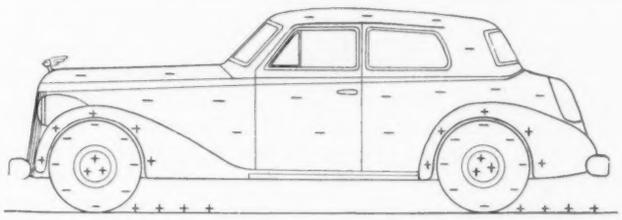


FIG. 5 THE NORMAL DISTRIBUTION OF CHARGES ON THE BODY OF AN ELECTRIFIED VEHICLE, SHOWING THE "WAKE" OF POSITIVE CHARGES IN THE ROADWAY

difference of potential increases rapidly as the surfaces are separated and in inverse proportion as the capacitance decreases ($C = Q/E$), attaining values of many thousands of volts. A similar condition is obtained by rubbing a metal with a nonconducting substance, provided the metal is insulated from ground so that it retains its charges.

As the wheels of vehicles roll along a roadway, the tires acquire electrons and thereby become highly charged with negative electricity. The positive atomic charges lie as "wakes" behind the speeding wheels in the surface of the roadway, and they have no further effect. However, the negative charges on the tires have a strong influence in electrifying the car body.

The high negative electrification on the tire treads repels to the more remote parts of the car body the free electrons in the metal of those parts that are in closest proximity to the tires, such as the wheels and fenders. This leaves high positive electrification on the adjacent metal parts as so-called "bound" charges; and the repelled electrons on the remainder of the metal parts of the car constitute what are known as "free" charges, because, if a path is provided for them, they will flow off to ground. Fig. 5 shows the normal distribution of charges on a car body. This separation of the charges on the car body is the well-known process of "electric" induction. In other words, the charges induced on the metal parts adjacent to the negatively charged tire treads are positive ions because the free electrons are repelled, and these positive charges and the negative charges on the tires are bound by a strong electric field which exists between them—a condition which is measured by their potential difference or the voltage.

If the negative charges on the tires are neutralized the rest of the car will resume its original uncharged condition. However, if the free negative charge on the body is removed by momentarily connecting it to a good ground and the negative charges on the tires are subsequently neutralized then the body retains a charge that is positive with respect to ground. These various conditions were measured and checked, both on road tests and on the Otis proving stand, by voltmeter, by microammeter, and by electroscope.

Curves are given in the paper which show voltage between car body and ground for various conditions. The voltage increases with speed, tractive effort, and tire air pressure, and decreases with higher tire temperatures and humid weather.

In dry cold weather potentials of over 15,000 volts were measured in highway driving, and at times there would be no apparent decrease during stops of 20 minutes or more.

Under these conditions the use of the so-called "drag" chain, as frequently seen with two or three links dangling on the pavement at the rear of gasoline trucks, was found to make no measurable difference in the rate of decrease of the voltage on the car. Since the pavement was not grounded, but rather comprised a most excellent insulator, the drag chains, obviously, could not be expected to discharge the car. Surface resistivities of roadways, as measured by a 1000 volt d-c megger, between two parallel metal-strip electrodes, each 4 in. long, and separated about $1/4$ in., ranged between 1500 megohms and values well beyond the 2000-megohm meter scale. Also tests taken of the resistance through the pavement to the ground beneath indicated values of a similarly high order. This was equally true for asphalt and concrete roadways.

Consider the case in which the body of the vehicle has been discharged of its "free" negative electricity by grounding it, as was previously explained. The tires still retain their high charge of negative electricity and the high positive electrification is still held "bound" at the wheels and fenders. This condition of "discharge" may have been attained through the grounding of the vehicle, say a tank truck, by means of the grounding grids that are sometimes used at the distributing or bulk stations of gasoline companies. Yet the potential hazards of sparks still remain. Any conducting object that is allowed to touch the tire and the fender may produce the necessary spark to initiate a fire or explosion.

The author hopes that his efforts to present the fundamental elements of static electricity on rubber-tired vehicles in these studies will be rewarded by their giving encouragement to others to attack various phases of the problem. Perhaps methods of reducing the generation of charge at the tire treads may be devised. This would strike at the very heart of the problem. A study of simple means for discharging the static electricity as it is generated offers an attractive field for investigation. Basically the civil engineer has an interest, if not a definite responsibility, in the problem, since the laying of modern highways which possess these high resistivities is a product of his conception. Perhaps he can solve the problem in some manner by devising a type of road surfacing that will be conductive.

BLACK-OUT LUMINAIRES

(Comparison of British (left) and General Electric fixtures for black-out street lighting. The British unit uses a 25-watt incandescent lamp shielded to produce only one candlepower of light. The American unit uses a $2\,1/2$-watt argon gaseous-discharge lamp which, in addition to one candlepower of visible light, emits invisible ultraviolet rays. In a recent demonstration in which these lamps replaced ordinary street lamps 100 feet apart, persons and objects could be seen at a distance of about 25 feet. Such lighting is not visible at more than a few hundred feet above the ground. Ground visibility is increased by painting signposts, fence posts, curbs, and even vehicles with fluorescent paints which glow under ultraviolet rays.)

The Cotton House

U. S. DEPARTMENT OF AGRICULTURE

THE Cotton House recently exhibited in the Department of Agriculture Patio in Washington, D. C., was conceived and designed to fulfill a twofold necessity: first, as an important consumer of the country's No. 1 surplus agricultural commodity, cotton; and second, as an important step in low-cost housing with especial reference to our defense needs.

Each structural unit is prefabricated in such manner that the house can be erected in 62 man-hours, and it has the additional advantage in that it can be demounted and re-erected on another site for additional years of service.

The prefabricated wall sections are made with $5/16$-in. Douglas-fir plywood which has been covered with 4-ounce cotton fabric hot-pressed to the plywood by the use of a special synthetic-resin adhesive.

The elimination of moisture in the construction process is definite assurance against subsequent cracks in the walls, floors, and ceilings, and provides a dry surface for immediate painting and immediate occupancy.

The floor, sidewall, ceiling, and roof sections are all constructed of stress-covered panels following the principles developed by the Department's Forest Products Laboratory. This method permits the use of 1 × 3-in. studs on 12-in. centers, yet when bonded to the inner and outer plywood surfaces with waterproof resins, they constitute a box beam which makes a load-bearing wall far stronger than the conventional wall of 2 × 4's. Floor panels loaded to 128 lb per sq ft over a $5\,1/2$-ft span showed a maximum deflection of only 0.19 in. This stiffness is developed because the full strength of the material is structurally utilized, with the upper surface under compression and the lower surface in tension.

The ceiling, sidewall, and floor units are tied to the sills by a system of steel rods. Houses of this construction are said to have successfully withstood the tropical climate of Wake Islands and the rigorous winters of Point Barrow, Alaska. In such extremes the increased comfort due to cotton insulation is marked.

Further details may be obtained from the Surplus Marketing Administration, U. S. Department of Agriculture.

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Surface Quality of an S.A.E. 3140 Steel

COMMENT BY M. E. MARTELLOTTI[1]

The authors have presented a report[2] of their investigation on the quality of surface finish obtained in facing cuts on S.A.E. 3140 steel disks, under various combinations of cutting speed, heat-treatment, and cutting fluids.

The results obtained under the specific conditions of their tests indicate that:

1 The quality of the machined surface improves with the cutting speed.

2 As the hardness of the material is increased, a good quality of finish can be obtained at a lower speed than that required for the same material in a softer state.

3 Cutting fluids improve the quality of finish at the lower cutting speeds, but are not equally effective at the higher cutting speeds.

In practical machining operations, there are numerous factors to be considered in relation to the economics of cutting, among them being the quality of finish, the tool life, and the power consumption. In practice, these factors, with the possible exception of power consumption, are equally important and efforts are usually directed toward improving both the quality of finish and tool life rather than sacrificing either of them for the sake of the other.

The authors call "optimum" cutting speed that speed at which the machined surface shows a definite improvement over the surface obtained at lower cutting speeds. The use of this term is rather ambiguous since it might also be taken to mean the particular cutting speed for which optimum conditions as to tool life and power consumption will result.

Actually, it is the cutting speed at which a definite change occurs in the physical conditions, both with respect to the cutting edge of the tool and the machined surface. This may, perhaps, be more appropriately called the threshold cutting speed.

The tool life depends upon the operating temperature at the tool point and on the wear of the cutting edge of the tool. They both increase with the cutting speed;[3] hence the optimum cutting speed as to surface quality is not necessarily the optimum cutting speed in relation to the tool life.

In exhaustive tool-life tests, conducted by R. Wallichs at Munich in 1938, on various kinds of tool material, he found that cemented carbide-tipped tools exhibit several types of wear, the most common being:

(*a*) Wear on the flank, or clearance wear.

(*b*) Wear known as "cupping" or "cratering" back of the edge of the tool.

The former, or clearance wear, develops when taking finishing cuts, while the latter is of more common occurrence in roughing cuts.

Wear on the flank of a cutting tool reduces the clearance angle and increases the area of the tool in rubbing contact with the freshly finished surface of the work, thus profoundly affecting the quality of the surface.

This is particularly important in the present case because the authors have taken light finishing cuts of short duration and, while they have obtained good finish under rather favorable experimental conditions, their results cannot be taken to apply equally well to an extended operation of the tool under shop conditions, without additional information on the tool life, as determined by the wear.

Therefore, the information on the quality of a machined surface is of a limited practical value without corresponding data on the tool life.

The improvement in the quality of finish with the cutting speed is a well-known occurrence in metal-cutting processes, and has been reported by many investigators.

In a paper,[4] presented in 1926, E. G. Herbert reported the formation of the "Whitaker ring" in the facing of a mild-steel bar. The surface within this ring is smooth and shiny, while the adjacent surface generated at either higher or lower cutting speeds is rough and dull in appearance. From a photomicrograph[5] of the surface taken near the outer edge of the ring, it can be seen that the surface of the ring is free from fragments of built-up edge, while the outer surface is not.

The tool temperature obtaining in the facing cut, as reported, was determined by E. G. Herbert, who found that, while the temperature of the tool rose progressively with the speed, at a certain speed range the temperature dropped from 395 C (743 F) to 370 C (698 F) and then again continued to rise to a maximum of 500 C (932 F) at the outer edge of the ring.[6]

The drop in the tool temperature, occurring in the region of the Whitaker ring, was attributed by E. G. Herbert to lowering of the work-hardening capacity of the material being cut, in the range of temperatures obtaining in this region.

The authors have stated that "the finish as shown for the speed of 461 fpm appeared to remain the same even for higher peripheral cutting speeds."

In facing tests, conducted in the research laboratory of the writer's company, both on S.A.E. 3115 steel and aluminum, the writer has found a periodic recurrence of the bright Whitaker ring as the cutting speed was progressively increased.

This was also indicated by the recurrence, in seemingly periodic manner, of the drop in the work-hardening capacity of the mild-steel bar used by E. G. Herbert in the tests cited[7] as the temperature of the bar was increased.

In the light of more recent work it appears evident that the cold-working capacity of the work material plays an important part in the formation of the chip and the consequent effects on the quality of the machined surface and on the life of the tool.

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[1] Research Engineer, The Cincinnati Milling Machine Company, Cincinnati, Ohio. Mem. A.S.M.E.

[2] "Surface Quality of an S.A.E. 3140 Steel," by O. W. Boston and W. W. Gilbert, MECHANICAL ENGINEERING, vol. 62, November, 1940, pp. 785–789.

[3] "Testing for Machinability by Measuring Temperature and Tool Wear," by H. Schallbroch, H. Shaumann, and R. Wallichs, Vorträge der Hauptversammlung, 1938. *Der Deutschen Gesellschaft für Metallkunde*, V.D.I. Verlag, pp. 34–38, 1938.

[4] "Work-Hardening Properties of Metals," by E. G. Herbert, Trans. A.S.M.E., vol. 48, 1926, pp. 705–745.

[5] Ibid., Fig. 33, p. 734.

[6] Ibid., Fig. 31, p. 732.

[7] Ibid., Fig. 34, p. 735.

An interesting result was obtained by the authors by varying the hardness of the work material, in that a good quality of surface finish could be obtained at a lower cutting speed than that required when the material was in a softer state.

If the values of the Brinell hardness are plotted on log-log paper against the values of the corresponding optimum cutting speed, a straight-line relationship is obtained, Fig. 1 of this discussion.

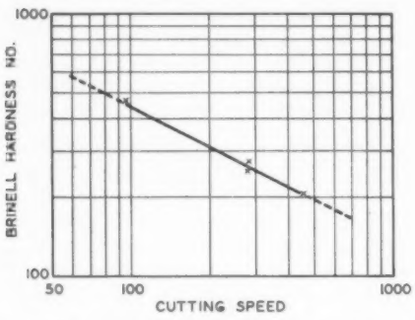

FIG. 1 BRINELL HARDNESS NUMBER VERSUS "OPTIMUM" CUTTING SPEED IN FEET PER MINUTE

This curve can be represented by the empirical equation

$$V = \frac{K}{B^n}$$

where

V = "optimum" cutting speed, fpm
B = Brinell hardness number
K and n = constants, where value of $n \approx 2$.

This investigation should be continued to include a variety of the more common materials, particularly the light alloys, which are usually cut at very high speed.

The available information relative to the effect of hardness of the work material on the cutting speed required to produce a given quality of finish is rather limited; any attempt to increase our knowledge on this particular subject should be encouraged.

The authors have found that, as the cutting speed is increased, the quality of the surface produced is but slightly affected by the use of cutting fluids. This is in agreement with results given in a paper[8] by Messrs. H. Ernst and M. E. Merchant.

It might be added, however, that a cutting fluid performs also the function of a coolant and that, at high cutting speeds, this function predominates over others not yet fully known, which are identified with the improvement in quality of finish found by the authors at the lower speeds. A cutting fluid, therefore, by reducing the cutting temperature, will lengthen the life of the tool.

E. G. Herbert has reported[9] the results of an investigation on the effect of various cutting fluids on the temperature of the tool, at progressively increasing speeds when turning a mild-steel bar. He shows[10] that a tool temperature of 932 F could be obtained by cutting dry at a speed of 60 fpm while, when water was used, the cutting speed had to be increased to approximately 200 fpm in order to obtain the same tool temperature.

COMMENT BY M. E. MERCHANT[11]

This paper represents a careful study of the type of surface quality obtained under various conditions when cutting S.A.E. 3140 steel. As such, it should be of considerable practical value to those interested in the machining of this particular steel.

In the specific conclusions reached by the authors, at least two major points are evident:

1 The finish obtained improves with increasing cutting speed, as long as a built-up edge is present at the cutting edge.

2 The finish is improved by good cutting fluids at low cutting speeds, but this improvement becomes less marked as speed is increased, until finally, at sufficiently high speeds, almost no difference in finish is obtained with or without any of the cutting fluids employed.

However, the authors report no attempt to ascertain the fundamental causes producing these observed changes in finish and, thus, the applicability of the results as presented is quite definitely limited to the particular steel studied, when machined under the particular test conditions used. The writer feels that it might be of interest to record the fact that these results may all be interpreted in terms of a simple fundamental method of analysis of general applicability.

All fragmentary roughness on machined surfaces (as differentiated from tool marks) can be attributed to portions sloughed off from the built-up edge, as shown by Ernst and Martellotti.[12] The magnitude of the roughness varies in general with the magnitude of the built-up edge, becoming smaller as the built-up edge decreases in size, and disappearing when the built-up edge ceases to exist. Therefore, surface finish may be directly related to whatever variable or variables are responsible for the presence and size of the built-up edge.

A recent experimental and theoretical study of this problem has shown that the major controlling variable in this phenomenon is the coefficient of friction existing at the rubbing surface between chip and cutting tool.[13] If this coefficient of friction is large, the built-up edge is large; while, if friction is low, the built-up edge is small or absent. The theoretical analysis has shown, furthermore, that, for a given material in a given state of hardness, a direct measure of the coefficient of friction between chip and tool is found in the percentage of compression in length suffered by the chip during removal.[13] The amount of this compression is very great when the coefficient of friction between chip and tool is high; while, if the friction is low, less compression in length is observed. This percentage compression is readily determined by measuring the ratio of the length of a given section of chip to the distance traveled by the tool in producing that section. The quantity so obtained may be called the "cutting ratio." Thus, the cutting ratio is a definite measure of the coefficient of friction between tool and chip for a given sample of material, and is thereby a direct measure of the surface finish being obtained on that sample. Furthermore, it can also be shown to be a direct measure of power consumption per volume of metal removed in cutting; the least power being consumed when the cutting ratio is largest. Therefore, the cutting ratio is a very important variable in cutting tests, one which has evidently been overlooked heretofore.

Interpreting the authors' experiments on S.A.E. 3140 steel in the light of this quantity, it is evident their results show that, if data on cutting ratio versus speed had been obtained and a curve plotted, it would have shown a general upward trend with increasing speed in the case of cutting dry. Furthermore, if data for a similar curve had been obtained when using a good cutting fluid, the value of cutting ratio at the lowest speed would have been higher than that obtained at this speed when cutting dry, but the values would have approached those obtained for dry cutting as the speed was increased.

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[8] "Chip Formation, Friction, and High-Quality Machined Surfaces," by H. Ernst and M. E. Merchant, presented at Annual Meeting of the American Society for Metals, Cleveland, Ohio, October, 1940, preprint No. 53, Fig. 27, p. 32.

[9] "The Measurement of Cutting Temperatures," by E. G. Herbert, Proceedings of The Institution of Mechanical Engineers, London, 1926, vol. 1, pp. 289–308.

[10] Ibid., Fig. 4, p. 292.

[11] Physicist, Research Department, Cincinnati Milling Machine Company, Cincinnati, Ohio.

[12] "Metal Cutting," by H. Ernst and M. Martellotti, MECHANICAL ENGINEERING, vol. 57, 1935, p. 487.

[13] For a partial discussion of this finding refer to paper by Hans Ernst and M. E. Merchant, footnote 8 of previous discussion.

Measurements of cutting ratio versus speed, cutting dry and with various fluids, have been made by the writer on annealed S.A.E. 52100 steel, and show exactly the same trends as outlined. The curves obtained are presented in Fig. 2 of this discussion.

It may be said that these same trends

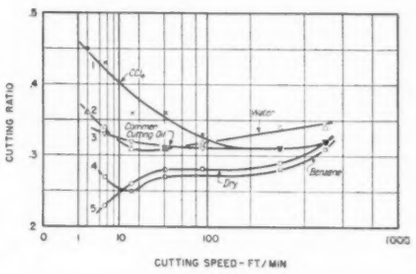

FIG. 2 CHART SHOWING RELATIONSHIP BETWEEN CUTTING RATIO AND CUTTING SPEED WITH VARIOUS CUTTING FLUIDS ON S.A.E. 52100

(1, Carbon tetrachloride; 2, water; 3, high-grade commercial cutting oil; 4, benzene; 5, dry.)

must always be observed in cutting any material dry, and with any of the usual cutting fluids. When cutting dry, the coefficient of friction at the chip-tool interface will decrease with increasing speed. When employing cutting fluids, a good fluid will considerably reduce the coefficient of friction when cutting at low speeds, but will ordinarily be less effective in reducing friction as speed is increased. The reasons for this behavior are fully discussed in the paper[13] mentioned.

COMMENT BY O. R. SCHURIG[14]

Studies of the kind reported in this paper are of real importance in guiding those who are responsible for setting standards for machining operations. The authors did particularly well in presenting the results in the clear and striking form of photomicrographs and surface profilograms featured together for each condition of test.

The authors indicate how surface quality, for several kinds of steel under specified conditions, depends upon the speed of cutting and how the quality of surface finish is vastly improved if the speed of cutting is increased, in one case to a value of 460 fpm. Greater attention than ever before is being paid to surface quality, as indicated by the fact that standards have been proposed for measuring this quality.

It is particularly important to know what cutting conditions to specify to obtain a smooth surface finish at a minimum cost, in terms of tools and time of the operators. Evidently, specifications to that effect would have to include more than a statement of feed, depth of cut, cutting speed, and cutting fluid for a given material to be cut.

The authors also indicate that the conditions for a good quality of surface finish are those under which the built-up edge recedes from the cutting edge so that the cutting edge itself actually produces the machined surface. Beyond this, it does not appear to be known what produces a built-up edge and what particular conditions must be satisfied to prevent its occurrence for heavy cuts at relatively high speeds.

It would also be valuable to have definite information concerning the factors which tend to reduce the surface roughness in the direction of cutting at low speeds. According to the authors, certain cutting fluids are of some help, but leave much improvement to be desired. It may be that a more complete specification of cutting conditions on a lathe, in so far as surface quality is affected, in addition to the items already mentioned, would require such additional items as flexibility and waviness variations permitted in the bed of the lathe, the rigidity and backlash of gears and of spindles, and the maximum allowable clearances in the bearings.

There is no doubt but that further researches will be carried out in this field, since it is evident that better and smoother surfaces will be produced at lower cost, when a clearer understanding is obtained of the fundamentals involved in the machining operations.

AUTHORS' CLOSURE

The discussions by Messrs. Martellotti, Merchant, and Schurig are very interesting, and have added materially to the value of the paper. Many suggestions for further work outside the scope of the paper have been made.

Dr. Martellotti has recast the conclusions of the paper under three headings, the first of which states: "The quality of the machined surface improves with the cutting speed." This statement does not agree wholly with the conclusions set forth in the paper, inasmuch as it is recognized that, at the relatively low speeds, the surface quality may actually become poorer with an increase in speed after which it improves. Dr. Martellotti further redefines optimum cutting speed as that speed at which the machined surface shows a definite improvement over the surface obtained at lower cutting speeds. The definition, as given in the paper, defines this optimum speed as the minimum speed at which the cutting edge of the tool actually cuts and produces a keen and smooth-cut surface. At all lower speeds, the chip is removed by means of a built-up edge which gives inferior surface quality. The relationship between this optimum speed and the Brinell hardness, as shown in Fig. 7 of the paper, follows the relationship of $V_{opt}B^{0.466} = C$ in which V_{opt} is the optimum speed, as defined in the paper, B is the Brinell hardness of the steel, and C is a constant computed to be approximately 3600. The second highest point in Dr. Martellotti's discussion showing these data should be moved to the left over its corresponding cutting speed of 248 fpm. This value of 248 fpm was taken from Fig. 6 of the paper.

It is recognized, as Dr. Martellotti points out, that, in practical machining operations, the quality of finish, the tool life, and power consumption are of importance. Chip formation is many times of greater importance than these. It has been found repeatedly, however, that these features are not correlated, but are quite independent one from another. It would be only a coincidence when the most favorable conditions of longest tool life, lowest power, best surface quality, and finely broken-up chips would be obtained simultaneously. A compromise must be made in every machining operation so as to favor that factor deemed to be of most importance. The optimum speed as used in this paper was not intended to refer in any way to the most favorable speeds for any of these other factors.

The effect of cutting speeds on tool life and the influence of cutting fluids for this same material were reported in a previous paper.[15] The current study was solely to determine the influence of the material itself on the surface quality when using a tool of more or less permanent shape. One of the advantages of using cemented-carbide tools is that speeds equal to or above this optimum speed can be maintained with satisfactory tool life. The values of the optimum speed, as given in the paper, will naturally change if other tool shapes, tool material, or size of cut are used, or if cutting fluids are introduced.

Reference is made to the "Whitaker ring," so called by E. G. Herbert because of its first observation by his associate Mr. Whitaker. The improved surface quality, as indicated by the Whitaker ring, usually occurs at speeds lower than the so-called optimum speed.

[14] General Engineering Laboratory, General Electric Company, Schenectady, N. Y.

[15] "The Influence of Cutting Fluids on Tool Life in Turning Steel," by O. W. Boston, W. W. Gilbert, and C. E. Kraus, Trans. A.S.M.E., vol. 58, 1936, p. 371; discussion, vol. 59, 1937, p. 343.

This has been reported also by J. S. Vanick and T. H. Wickenden.[16] To produce this ring in facing with a radial feed, the built-up edge may become stable over a narrow range of speeds to give an improvement in surface quality. However, at the optimum speed, the high cutting speed has caused the built-up edge to recede entirely from the cutting edge, so that the cutting edge itself cuts, producing a clean-cut surface.

Mr. Merchant in his discussion states: "All fragmentary roughness on machined surfaces (as differentiated from tool marks) can be attributed to portions sloughed off from the built-up edge, as shown by Ernst and Martellotti. . . ." If there is no built-up edge because of the high cutting speed, then there can be no sloughed-off particles, and a smooth surface, different from that such as the Whitaker ring, results. In the tests by Vanick and Wickenden, as well as those by Herbert, the smooth surface of the Whitaker ring became rougher again at higher cutting speeds. This is not so in the case of this report. The paper reports that there is no change in surface quality at speeds higher than the optimum speed.

In Fig. 33 of Herbert's work,[4] referred to by Dr. Martellotti, the smooth surface was undoubtedly caused by momentarily more stable built-up edge, and it appears that the surface quality even so was far more irregular or rougher than that produced at the so-called optimum speed. The authors believe that the "cutting ratio" may be a function not only of the coefficient of friction between the tool and work, but also may be effected by the work hardening of the chip. E. G. Herbert[17] goes so far as to state: "The measure of machinability is the hardness of the chip. . . ." and ". . . The original hardness of the steel has no significance and can have no significance, in relation to machinability, since original hardness does not exist in the metal machined; and the same must apply to the tensile strength, which is known to be a function of original hardness." Machinability in his case refers to permissible cutting speed. In his Table 2, Herbert[4] reports on the effect of chip thickening when cutting a mild-steel bar, and shows the greatest thickening (Martellotti's lowest cutting ratio) at both low and high speeds, with a minimum of chip thickening at medium speeds.

Mr. Schurig's recommendation concerning methods of obtaining better surface finishes is timely. In general, it is necessary to reduce the size of the built-up edge in order to improve the surface finish. However, to lengthen the tool life, it is beneficial to have a built-up edge to protect the cutting edge of the tool.

O. W. BOSTON.[18]
W. W. GILBERT.[19]

Rubber Springs Under Load

COMMENT BY M. F. SAYRE[20]

Our knowledge of the physical behavior of rubber under load is now passing through the very necessary stage of experimentation on specific cases, followed by publication of data. This paper[21] represents a valuable addition to our rapidly increasing library of information of this character.

It is hoped that the next stage may be the development of general principles, each covering many of these special types of loading. Obviously, this will be much more difficult for rubber than it has been for steel, with its smaller deflections and its obedience to Hooke's law. However, it is a sufficiently important task to justify considerable effort on the part of experimenters with rubber.

Progress in this direction would be hastened and thought on the subject would be clarified if for rubber the term "modulus of elasticity in compression" could be placed under some form of taboo. Modulus of elasticity in shear is a definite physical characteristic of the rubber itself. Behavior in simple compression or tension, however, depends to so great a degree upon the physical shape of the specimen, particularly the height to least width ratio, that it is misleading to draw a stress-strain curve and label its slope the "modulus of elasticity" of the material. A much more accurate terminology would be the "spring rate of the specimen." This in turn should be thought of as dependent upon the modulus of elasticity in shear of the rubber, the dimensional characteristics of the specimen, and the type of loading.

AUTHOR'S COMMENT

The author is in complete agreement with Professor Sayre's comments. The use of the term "modulus of elasticity in compression" is unfortunately overdone in the literature on rubber applications. I believe that Professor Sayre's suggestion that this be changed to "spring rate" is a good one. He noted that this spring rate should be dependent upon the modulus of elasticity in shear of the rubber, the dimensional characteristics of the specimen, and the type of loading. This is true; especially if in "type of loading" he includes the end conditions of the rubber sample. Among these might be stated: Whether the rubber is bonded to metal, and, if unbonded, what lubrication, if any, exists between the metal and the rubber. These end conditions play an extremely important part in determining the variation of the spring rate.

J. F. DOWNIE SMITH.[22]

Railroad-Car Suspension

COMMENT BY K. F. NYSTROM[23]

The design of the railroad car, described in this paper,[24] as developed by the Pacific Railway Equipment Company, is novel and interesting from an engineering point of view. The basic principles underlying this design are considered to be fundamental, by suspending the car body above its center of gravity to aid in controlling lateral motion and improving the comfort and stability of the car on curves.

The control of lateral motion, the first objective, is more or less satisfactorily corrected in so-called conventional truck designs by lowering substantially the center of gravity of the car body by placing heavy equipment, such as batteries and air-conditioning equipment, underneath the center sills and, at the same time, raising the level of the truck springs. This new pendulum type of cars should correct the rolling of the car body on curves due to centrifugal force, thus taking care of the second problem.

The designers have set out to obtain an ideal. Only actual tests with regular equipment under high-speed-service con-

[16] "Smooth Finish Machining of Low Carbon Plain and Alloy Steels," by J. S. Vanick and T. H. Wickenden, Trans. A.S.S.T., vol. 11, 1927, p. 551.

[17] "Report on Machinability," Cutting Tools Research Committee, The Institution of Mechanical Engineers, London, England, December, 1928.

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[20] Professor of Applied Mechanics, Union College, Schenectady, N. Y. Mem. A.S.M.E.

[21] "Rubber Springs Under Compression Loading," by J. F. Downie Smith, MECHANICAL ENGINEERING, April, 1941, pp. 273–277.

[22] Research Division, United Shoe Machinery Corporation, Beverly, Mass. Mem. A.S.M.E.

[23] Mechanical Assistant to Chief Operating Officer, Chicago, Milwaukee, St. Paul and Pacific Railroad Company, Milwaukee, Wis. Mem A.S.M.E.

[24] "A Fundamental Development in Suspension and Construction for Railroad Cars," by P. K. Beemer, F. C. Lindvall, E. F. Stoner, and W. E. Van Dorn, MECHANICAL ENGINEERING, vol. 62, November, 1940, pp. 779–784.

ditions can determine if this is possible of accomplishment. From the writer's experience, a railroad vehicle may ride entirely satisfactorily at a given speed, say 60 mph, but a speed below or above this may change the behavior of the car entirely. This is mentioned since the new design of truck may have some critical speed such as automobiles and railway cars have in common today.

The available floor space in square feet in a railway car is what pays returns on the investment and, with the pendulum type of car, considerable floor space must be sacrificed to house the projecting truck parts. It is hoped that the advantages obtained from this design will warrant this sacrifice of floor space. Maximum speed is determined by the condition of roadbed, elevation of curves, and the safe handling of the power unit, whatever type it may be, steam, electric, or Diesel. If the latter is the determining factor for maximum speed, probably a modification of the pendulum type of car will be the final outcome. At any rate, the authors of this paper, who are also the designers, deserve both acknowledgment and credit for their valuable contribution to the car-building art.

COMMENT BY J. C. SILLIMAN[25]

In the section of the paper, "Relative Strength of Conventional and Stressed-Skin Structures," the writer would like to call attention to an inconsistency in the determination of the strengths of the two panels discussed.

The writer suggests the use of the "effective-width" formula for expressing the ultimate load the $25\frac{1}{2} \times 34$-in. panel, shown in Fig. 7(*a*), can carry. The comparison at present, where only the buckling load is figured for the panel in Fig. 7(*a*), whereas, the ultimate load is determined for the panel in Fig. 7(*b*), is not a true comparison. The author states in his assumptions that the panels in Fig. 7, are simply supported along the edges. If this is true, then there will be an effective width of skin acting along each edge which he does not take into account. This applies to both panels. This support of the outer edges of either panel would be derived from the belt rail and side sill. All symbols used are as set forth in the original paper.

(*A*) Then for panel (*a*), Fig. 7(*a*)

$$W_e = 1.7h\sqrt{\frac{E}{\sigma_s}}$$

In either panel, the value of σ_s will be 40,000 psi.

$$W_e = 1.7 \times 0.094\sqrt{\frac{29 \times 10^6}{40{,}000}}$$

$$= 1.7 \times 0.094 \times 26.9 = 4.3 \text{ in.}$$

The effective loaded area then will be

$$\text{Area} = 4.3 \times 0.094 = 0.404 \text{ sq in.}$$

The ultimate panel load then will be

$$P_{ult} = 40{,}000 \times 0.404 = 16{,}200 \text{ lb.}$$

(*B*) The added load that panel Fig. 7(*b*) can carry, resulting from the simply supported outer edges, is calculated as:

$$P_{\text{additional}} = 40{,}000 \times h \times W_e$$

$$= 40{,}000 \times h^2 \times 1.7\sqrt{\frac{E}{\sigma_s}}$$

$$= 40{,}000 \times 0.06^2 \times 1.7 \times 26.9$$

$$= 6600 \text{ lb}$$

The total strength of panel (*a*) is 16,200 lb, and for panel (*b*) is 35,600 + 6600 = 42,200 lb. Panel (*a*) has a strength-weight ratio of $\frac{16{,}200}{23.2} = 698$.

The strength-weight ratio of panel (*b*) is $\frac{42{,}200}{17.7} = 2380$.

The strength-weight ratio of panel (*b*) is then $\frac{2380}{698} = 3.41$ times that of panel (*a*) instead of $\frac{2010}{119} = 16.9$ given in the paper.

COMMENT BY W. L. WATERS[26]

Pendulum cars were tried 50 years ago to give easier riding around curves on some narrow-gage railways in Europe. However, as the cars were swinging all the time, they were only run at slow speeds. It is interesting to note that by utilizing the high-speed-car-design experience of the last 10 years, a pendulum car has been built which has run at 90 mph. It must not be forgotten, however, that the standard type of car is the result of 50 years' experience and that many unexpected effects develop in extended commercial operation which are not evident on test runs. It will require years of operating experience before the pendulum car can be finally judged. The modern lightweight streamlined train owes its success largely to its advantages on special runs and to its glamour, which has an appeal in the public mind. Assuming that extended experience indicates the practicability of the pendulum car from an operating standpoint, it will be interesting to see if it will attract sufficient additional patronage to compensate for its experimental character and for the higher first cost per unit seating capacity which it seems may be one of its handicaps.

Textile Drying

COMMENT BY M. A. GOLDMAN[27] AND HERMAN RAPPOLD[28]

The author is to be commended upon the presentation of so excellent and informative a paper.[29]

A source of heat, being used with textile driers, which shows great promise for the future, is high-pressure hot water. With this system, adaptable to practically every type of drier, water is circulated by means of a centrifugal pump from a point in the boiler below the water level, through the equipment to be heated, and back to the boiler. The water is at boiler pressure (generally 50 to 200 psi) and has a temperature corresponding to that pressure. All trap, receiver-tank, hot-well, flash-loss, and make-up water troubles are eliminated. Flash loss, bypassing of traps, and lowering condensate temperature to permit satisfactory pumping, all present in steam systems, affect the economy of heating or drying. Elimination of such losses means a saving of from 20 to 40 per cent in fuel costs. A given volume of water contains more heat units than the same volume of steam, which means that the piping can be made smaller, with lower insulation costs and less heat loss. Temperature control is readily obtained and accurately held by throttling the volume of water going to the user.

CLOTH DRYING

The conventional tenter frame stretches the fabric and subjects one or both surfaces to blasts of hot air, as is done in the drying of impervious sheet material such as paper, wallboard, etc. Because of the multiplicity, intricacy, and precision of the component parts and because of the extensive floor space required by the tenter, this type of apparatus is expensive in initial cost and in maintenance. We have found that higher efficiency can be obtained if advantage is taken of the foraminous structure of woven fabric and the hot air is made to pass at high velocity through the interstices of the cloth, so that the hot dry air can act intimately upon the surfaces of the separated yarns.

The apparatus consists of a stack of skeleton cylinders, the surfaces of which are made up of small-diameter skeleton spreader rolls. Fans located within the cylinder draw hot dry air through the cloth which is conveyed, supported, and

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[27] Fibre Products Laboratories, Inc., New Brunswick, N. J.

[28] J. O. Ross Engineering Corporation, New York, N. Y.

[29] "Textile Drying," by Fred Kershaw, MECHANICAL ENGINEERING, vol. 62, December, 1940, pp. 871–874.

stretched by the spreader rolls. The revolving spreader rolls do not leave stick marks.

This rotary tenter frame performs with advantageously comparable results, occupies $^1/_{11}$ of the floor space of the conventional tenter, and requires a minimum of attendance. The cost of construction is low and the small upkeep is consistent with the simplicity of design.

Driers of this type are being successfully used in the drying of tire fabrics and are adaptable to other textile drying.

REMOVAL OF FREE WATER FROM FIBER RAW STOCK

Good textile fabrics reflect the care that was taken in the treatment of the fiber raw stock. Particular care is necessary for the treatment of fiber raw stock in the wet state. The mechanical operation of removing free water from the fiber stock between wet treatments or before drying should be such that it does not damage the fibers or mat the stock.

The high-pressure squeeze rolls for this purpose, operating at several hundred pounds per square inch pressure on the stock, crush and cut the fibers, and mat the stock, particularly cellulose-fiber stock.

Our advice for the removal of free water from fiber stock is that it should be done by moving air through the stock at velocities of 50,000 to 100,000 fpm, linearly. The air at these velocities friction-wipes each fiber with a pressure of 6 to 10 psi and removes more free water from the fiber stock than can be done by any other practicable mechanical means. The stock is opened to the correct freeness for efficient drying and the fibers are intact.

The horsepower required to move such volume of air through the stock is many times that required for the operation of squeeze rolls, but the evaporation drying that is necessary after this process is considerably less than that after squeeze rolls. The damp stock, after this air-wiping process, contains only 25 to $33^1/_3$ per cent of moisture. The machinery for this practice consists chiefly of a finely partitioned cage roll that is revolved over a stationary opening. The wet stock in continuous-lap form rides on about 90 per cent of this roll at the speed of the line production, without manual attention.

The efficiency of this process depends upon the uniform density of the lap of wet fibers, which is passed over the cage roll. It is practical to place the wet picker and this extractor in line before the drier for continuous production in lap form from the picker through the drier. This unit reduces the evaporating load and lowers the cost of drying.

COMMENT BY B. G. H. VON DER JAGT[30]

In France, in the not distant past, the writer, in connection with drying cocoanut fiber, acquired considerable experience in the use of hot water instead of steam in drying apparatus similar to that described in the paper. The system was changed from steam to hot-water heating without any change in pressure (the same boiler was utilized), namely, about 84 psi. Shortly after the change, it was determined that better results were obtained with hot-water heating than had formerly been the case with steam. It was also discovered that the speed of the conveying apron could be raised. With proper circulation of the hot water, provided by means of a centrifugal pump, it was possible to eliminate all steam traps, which were sources of continual discomfort. Better calorific results were obtained with hot water.

Turbulence and Combustion

COMMENT BY A. R. MUMFORD[31]

The paper[32] by B. J. Cross is an interesting presentation of the changes in the methods of firing pulverized-coal furnaces which have resulted, in the specific cases mentioned, in improvement of combustion, as evidenced by the decrease in loss due to solid combustible.

The difference in amplitude of the variations in furnace pressure in different furnaces with different types of firing is particularly intriguing. Is it possible that, if secondary-air pressure were varied in accordance with the chart in Fig. 5 of the paper but in the same furnace, results could be obtained which were related to turbulence in a manner similar to those contained in different furnaces? If this latter effect were found to be so, it would provide an interesting tool to measure a quality of combustion which would be of interest to the Coal Testing Code Committee of the Fuels Division of which R. L. Rowan is chairman. It is recognized, of course, that the pressure of the secondary air cannot be raised while holding the rating constant without increasing the resistance of the ducts between the fan and the furnace, but it is presupposed that such a variation would be accomplished by so altering the burner resistance as to increase the kinetic energy primarily at the jet. If data are available permitting a measure of the effect of turbulence by changing jet velocities while holding the air quantity constant, they would be of particular interest.

The United States Bureau of Mines has reported some experiments on the burning of pulverized coal in the furnaces of a Scotch-marine boiler, in which the theory of the manufacturer required that the pulverized coal and air be completely mixed and enter the furnace at the minimum velocity possible for any given rating. Under such conditions a minimum turbulence would exist in the furnace. It was found that the efficiencies obtained were 60 to 70 per cent, even though waste-heat-absorbing equipment was installed. Photographs, taken of the furnaces and published,[33] show large quantities of glowing combustible matter deposited from the gas stream on the bottom of the furnaces. Samples of solid combustible in the gas stream leaving the boiler showed exceptionally high losses compared with present-day standards. Evidently the attempt to reach a condition of no turbulence was largely successful and the lack of turbulence caused high combustible losses.

In a paper[34] published some years ago, certain experiments were described on the combustion of small sizes of anthracite on chain-grate stokers. In order to mix the gases high in oxygen, which rose from the ashpit end of the stoker, with the gases rich in gaseous combustible which rose from the front half, horizontal steam jets were installed above the stoker at the ashpit. The jets were supplied with saturated steam at 150 lb pressure. This pressure was sufficient to mix the gases and result in the completion of combustion before the gases reached the boiler. However, jets of air at only 4 in. of water pressure had insufficient energy to penetrate the gas streams and passed through the furnace in a stratified form. Evidently turbulence requires energy and velocities or kinetic energies of the jets to overcome the high kinematic viscosities of gases at high temperatures.

In the author's exposition of the relation of Reynolds' number to turbulent flow, the influence of kinematic viscosity is evident. At high temperatures, of the order of 3000 F, the kinematic viscosity of air is approximately 20 times that at room temperatures. Thus, it is apparent that kinetic energies must be high to produce turbulence in furnaces containing

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[32] "Turbulence and Combustion in the Pulverized-Coal Furnace," by B. J. Cross, MECHANICAL ENGINEERING, March, 1941, pp. 203–207 and 210.

[33] "Tests of Marine Boilers," by H. Kreisinger, and others, Bulletin No. 214, U. S. Bureau of Mines, Government Printing Office, Washington, D. C., 1924.

[34] "Combustion of Small Sizes of Anthracite on Chain-Grate Stokers," by A. R. Mumford, MECHANICAL ENGINEERING, vol. 46, 1924, pp. 138–142.

gases at temperatures approaching 3000 F with such high kinematic viscosities.

It is evident that some additional data, on the effect of several different jet velocities as one parameter and combustible in flue dust as the other, with other elements constant, would be of much interest.

COMMENT[35] BY P. NICHOLLS[36]

This paper is interesting in that it presents a new viewpoint of a complex action. Usually one must be content to define the degree of turbulence by a description of the type and magnitude of the imposed conditions, and not by measurements of the magnitude of the resulting turbulence. The author indicates his opinion of the relative degree of turbulence with different designs of furnace in the graphical representations of Fig. 4 of the paper. However, the effectiveness of turbulence must depend not only upon its magnitude but also upon its distribution through the combustion volume, which should be such that it produces mixing when and where it is most required; this factor is more elusive than is magnitude.

Fig. 5 plots carbon loss against pressure of secondary air; the use of pressure as a measure of secondary air has occurred in other papers. Would it not be possible (and a better record) to use jet velocity instead of pressure? The velocity and not the pressure is the more direct measure of the cause of turbulence.

The measurements of pressure pulsations shown in Figs. 7 and 8 are most interesting, and it may be hoped that the work will be continued until a more assured explanation of the meaning of the records is obtained. The paper does not show the exact positions of the pressure taps, particularly for those of primary and secondary air in Fig. 9. The interest is in how and where the pulsations originate; presumably they result from small explosions. It would be expected that these occur near the burners. Has the author any other explanation? Again, are all the pressures of all figures measured against air or are some differential? If the latter, the pulsations at the two locations may be out-of-phase and it may either increase or decrease the recorded amplitude.

These pulsation measurements may become a useful new tool and certainly they arouse one's curiosity.

AUTHOR'S CLOSURE

The curves of Fig. 5 to which Mr. Mumford refers, are based on data from one furnace. This furnace was equipped with four burners of the type indicated in Fig. 4*c*, that is, the horizontal "turbulent" type burner. These burners have adjustable secondary-air vanes so that a range of pressure is possible at a given rating. The excess air was held practically constant at each rating.

Mr. Mumford's comment on the early applications of pulverized coal to marine boilers is interesting. When it was attempted to supply all of the air with the coal, the velocities were necessarily low in order to secure ignition of the lean mixture that resulted. There was, therefore, but little energy in the stream available for the creation of turbulence and mixing.

His observation as to the relative effectiveness of jets of steam at 150 lb pressure and of air at 4 in. pressure in reducing the combustible loss in gases over stokers is in line with the author's own experiences with pulverized coal furnaces. Many of the early pulverized-coal furnaces, which were usually storage systems, vertically fired, had burner nozzles equipped with steam-jet aspirators which could be used in the event of a failure of the primary-air blowers. These jets were sometimes used at high ratings to augment the supply of primary air. In such instances, a noticeable improvement in combustion was obtained. These steam jets produced a low-pitched though definitely audible tone. Neither the audible tone nor the same degree of improvement in combustion resulted when compressed air at lower pressures was used instead of steam.

The association of low-frequency sound waves and improved combustion conditions has been known for some time. In an experiment made about fifteen years ago, an attempt was made to obtain more complete combustion in a pulverized-coal furnace by attaching, to the secondary-air ducts, organ pipes designed to produce vibrations of about 20 per sec or just about the lower audible frequency. Little measurable effect in reduced carbon losses was obtained. It was later concluded that the furnace atmosphere had already a high degree of vibration and that the addition of one more wave could be expected to have but little effect.

Mr. Nicholls remarks on the use of pressure instead of velocity which is more directly the cause of turbulence in a furnace. In most of the installations studied, a direct measure of velocity would be very difficult and in many cases impossible. Secondary-air pressures were therefore taken and assumed to be a measure of velocity. The pressure taps were located as close as possible to the burner orifices so that air-duct losses were not included.

The pressure pulsations of Figs. 7, 8, and 9 to which Mr. Nicholls refers are in part associated with the combustion process and as he suggests may result from small explosions. An inspection of the graphs of these figures shows pulsations of larger amplitude than the average and of irregular period. However, the main ribbon of the graph consists of regular vibrations of higher frequency.

In short, there seems to be what may be called a "microturbulence" which appears to be inherent in a high-velocity jet. It is of the nature of a sound wave consisting of rarefactions and condensations. It entails molecular movement. These higher-frequency vibrations can be measured in the primary- and secondary-air streams with the furnace unfired. They may also be detected in the furnace atmosphere of a cold furnace but at a very much reduced amplitude. It is of course impossible to reproduce, in a cold furnace, the order of velocities that occur when it is in service.

The larger-amplitude pulsations of irregular frequency appear to be caused by a turbulence of the burner streams. This may be termed "macroturbulence." These pulsations are usually accompanied by a "swishing" sound. It is possible that these pulsations may be due to irregularities in fuel feed or ignition.

All of the pressures shown in the graphs were measured against the boiler room atmosphere. There is no assurance that this atmosphere itself is free of pulsation. In fact, as measured against outside atmosphere, changes in pressure of as much as 0.6 inch were observed. These pressure changes of inside and outside air were, however, gradual and not periodic. It would no doubt be better to have a large closed container having rigid walls to use as a reference atmosphere in measuring the drafts and pressures.

B. J. CROSS.[37]

"Through a Glass, Darkly"

TO THE EDITOR:

Mr. Batt's address[38] was both interesting and timely. But in his references to the world in general (as distinct from this country alone) the writer is afraid he underestimates the difficulties of post-war planning. To suggest shutting up a

[35] Published by permission of the Director, Bureau of Mines, U. S. Department of the Interior, Washington, D. C.

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[37] Assistant Engineer, Research and Development, Combustion Engineering Co., Inc., New York, N. Y. Mem. A.S.M.E.

[38] "Through a Glass, Darkly," by W. L. Batt, MECHANICAL ENGINEERING, vol. 63, no 1, January, 1941, pp. 5–8.

committee in a back office to solve the problems rather savors of "slide-rule-engineering." The Versailles Treaty which has been responsible for the present European difficulties was the result of such star-chamber proceedings. The committee in its enthusiasm forgets that the nations whose future it is handling like so many chessmen consist of proud virile peoples, each with an individual personality, the result of a thousand years of history.

The writer who was born and brought up in England and who had worked in three other European countries before he came to this country is still being continually astonished at the dense American ignorance of the English mind and the corresponding English ignorance of the American mind. Between peoples speaking different languages the ignorance is even greater. As a result of this, the idea of comprehensive world political or economic planning becomes merely an Utopian dream. Because of its national individuality each country must work out its own salvation. Nations cannot be handled like chessmen.

Europe is weary, cynical, and selfish; and the boyish enthusiasm and steadfast idealism of America is what Europe so badly needs. Let this country avoid being mixed up in details it does not understand. Leave these to the individual peoples themselves; and let America supply the inspiration.

W. L. WATERS.[39]

[39] Consulting Engineer, New York, N. Y. Mem. A.S.M.E.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code is requested to communicate with the Committee Secretary, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting of the Committee.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and also published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of May 23, 1941, subsequently approved by the Council of The American Society of Mechanical Engineers.

CASE No. 753 (Reopened)

(Special Ruling)

Inquiry: Do attachments on Pars. U-68 or U-69 unfired pressure vessels which are not pressure-resisting parts necessarily have to be stress relieved where stress relieving of the vessel, as a whole, is required?

Reply: It is the opinion of the Committee that all heavy attachments, such as supporting lugs which are welded on to Pars. U-68 or U-69 unfired pressure vessels, for which stress relieving as a whole is required, should be stress relieved. Attachments, the failure of which would not affect the safety of such vessels, need not be stress relieved, provided the requirements of Par. P-186 of the Power Boiler Code for the welding of nonpressure parts are complied with.

CASE No. 932

(Interpretation of Par. P-281)

Inquiry: The maximum safety valve blowdown permitted under Par. P-281(*a*) is 4 per cent of the set pressure. Tests show that safety valves used on a forced-circulation boiler of the once-through type may not operate satisfactorily under such a limitation. Is it permissible to use safety valves with a maximum blowdown of 10 per cent of the set pressure on boilers of this type?

Reply: It is the opinion of the Committee that safety valves with a maximum blowdown of 10 per cent will meet the intent of the Code when used on forced-circulation boilers of the once-through type. A safety valve for this special use may be adjusted for the 10 per cent blowdown and must be so marked.

CASE No. 933

(In the hands of the Committee)

CASE No. 934

(Special Ruling)

Inquiry: Will unfired pressure vessels fabricated by fusion welding under the test requirements of Pars. U-69 and U-70 meet the Code provisions if the base metal is of copper conforming to Specifications S-20, S-21, S-22, or S-23, except that the material covered thereby is obtained in the deoxidized condition?

Reply: It is the opinion of the Committee that deoxidized copper material conforming to any of the above-mentioned specifications may be used for the construction of unfired pressure vessels by fusion welding under the general requirements of Pars. U-69 or U-70. For vessels constructed under either paragraph, the welding requirements of Pars. U-69, UA-54 to UA-70, inclusive, shall apply except that:

(1) The elongation as determined by the free-bend test be not less than 30 per cent for Par. U-69, and not less than 20 per cent for Par. U-70 construction;

(2) Stress relieving is not required.

The rules of Par. U-20 shall be applied by using Table U-3 values for allowable working stress multiplied by:

(*a*) For Par. U-69 construction, 80 per cent joint efficiency;

(*b*) For Par. U-70 construction, the ratio of *SE* values given in Par. U-70(*a*) divided by 11,000.

CASE No. 935

(Special Ruling)

Inquiry: Will unfired pressure vessels fabricated by fusion welding under the requirements of Pars. U-69 and U-70 meet the Code provisions if the base metal is annealed nickel-copper alloy material conforming to Specification S-54 (minimum tensile strength, 70,000 lb per sq in.)?

Reply: It is the opinion of the Committee that nickel-copper alloy plate and sheet conforming to the above-mentioned specification may be used for the construction of unfired pressure vessels by fusion welding under the general requirements of Pars. U-69 or U-70. For vessels constructed under either paragraph the welding requirements of Pars. U-69, UA-30 to UA-53, UA-54 to UA-70, inclusive, shall apply except that:

(1) The elongation as determined by free bend test be not less than 30 per cent for Par. U-69, and not less than 20 per cent for Par. U-70 construction;

(2) Stress relieving is not required.

The rules of Par. U-20 shall be applied by using Table U-3 values for allowable working stress multiplied by:

(*a*) For Par. U-69 construction, 80 per cent joint efficiency;

(*b*) For Par. U-70 construction, the ratio of *SE* values given in Par. U-70(*a*) divided by 11,000.

Books Received in Library

ATM (Archiv für technisches Messen), Lfg. 106, 114, 115, April, 1940, December, 1940, January, 1941. R. Oldenbourg, Munich and Berlin, Germany. T37-48; T130-139; F6, 7; T1-15, F1. Paper, 8½ × 12 in., illus., diagrams, tables, charts, 1.50 rm each. Three numbers of a monthly publication containing classified articles upon various types of apparatus and methods for technical measurements. Some of the numbers also contain descriptions of specific instruments manufactured by German companies.

Air Raid Precautions Handbook No. 11, CAMOUFLAGE OF LARGE INSTALLATIONS. His Majesty's Stationery Office, London, England. Paper, 4 × 6½ in., 15 pp., illus. (obtainable from British Library of Information, New York, N. Y., $0.10). This pamphlet describes in general terms the measures which may be taken by way of camouflage to render factories and other buildings less distinguishable from the air. Illustrations and color plates are included.

AIRPLANE METAL WORK. Vol. 3, Airplane Sheet Metal Pattern Development and Template Making. By A. M. Robson. D. Van Nostrand Co., Inc., New York, N. Y., 1941. Paper, 7 × 9½ in., 102 pp., illus., diagrams, tables, $1.25. Intended both for mechanics actively engaged in the aircraft industry and for prospective mechanics in training, this book is designed to provide a correlation of the fundamentals of general sheet-metal pattern development to the aircraft industry. Resulting from the author's practical experience, it covers basic operations, calculations, actual pattern development, and comprehensive lists of tools and shop equipment.

AMERICAN YEAR BOOK, a Record of Events and Progress, Year 1940. Edited by W. M. Schuyler and A. B. Hart. Thomas Nelson & Sons, New York, N. Y., 1941. Cloth, 5 × 8 in., 1079 pp., tables, $7.50. This annual presents a survey of events during the year 1940 in 27 major fields of activity. Economics, business, and science are represented, including surveys of the mineral industries, manufactures, transportation, mathematics, chemistry, physics, engineering, and construction. The material is contributed by recognized authorities. Lists of related periodicals, societies, and research institutions accompany each section, and there is a comprehensive index.

ANODIC OXIDATION OF ALUMINUM AND ITS ALLOYS. By A. Jenny, translated by W. Lewis. Chemical Publishing Co., New York, N. Y., 1940. Cloth, 6 × 9 in., 231 pp., illus., diagrams, charts, tables, $6.50. This monograph deals with the electrolytic and chemical production of protective films on aluminum and its alloys, and with their uses in practice. An introductory study of the relevant electrochemical theory is presented. The original text, as translated from the German, has been supplemented with additional information.

CHEMICAL WARFARE. By C. Wachtel. Chemical Publishing Co., Brooklyn, N. Y., 1941. Cloth, 5½ × 9 in., 312 pp., diagrams, tables, $4. This currently important topic is covered in all of its ramifications. The history of the subject, including the men responsible for its development, is briefly presented; the various classifications of gases by composition and physiological effects are given in detail; and statistics and other pertinent material are included. Both the practical military application of the gases and protection against them are considered.

COMPOSITION OF FURNACE ATMOSPHERES RESULTING FROM PARTIAL COMBUSTION OF GASEOUS FUELS. (American Gas Association Testing Laboratories, Bulletin No. 11.) Cleveland, Ohio, 1940. Paper, 7 × 10 in., 91 pp., illus., diagrams, charts, tables, $1.25. Four progress reports and some new data are summarized in this bulletin which deal specifically with studies of the composition of flue gases resulting from combustion of different types of fuel gases with a deficiency of air. The test equipment and procedure are described, results are discussed, and a practical interpretation of the data is presented.

DAVISON'S RAYON AND SILK TRADES, the Standard Guide. 46th Annual 1941, pocket edition. Davison Publishing Co., Ridgewood, N. J., 1941. Cloth, 5 × 7½ in., 440 pp., illus., maps, $5.50. This directory of mills, dyers, finishers, and dealers in the rayon and silk trades contains both geographical and classified lists, as well as an alphabetical index. A buyers' guide indicates sources for equipment, and the railroads serving the various plants are listed.

DESIGN FOR INDUSTRIAL CO-ORDINATION. By R. W. Porter. Harper & Brothers, New York, N. Y., and London, England, 1941. Cloth, 6 × 9½ in., 249 pp., diagrams, charts, $3. This book, the work of a management consultant of long experience, shows how and why the structure of business organization and the elements of coordination which make it function efficiently form a technical design within which management must operate for best results. The problems of industrial management are classified, and twenty-one elements of performance are given upon which the author bases the effectiveness of the general pattern. A late chapter indicates ways to measure results.

DESIGN OF MACHINE ELEMENTS. By V. M. Faires. Revised edition. The Macmillan Co., New York, N. Y., 1941. Cloth, 6 × 9½ in., 490 pp., illus., diagrams, charts, tables, $4. PROBLEMS ON THE DESIGN OF MACHINE ELEMENTS. By V. M. Faires and R. M. Wingren. The Macmillan Co., New York, N. Y., 1941. Paper, 6 × 8½ in., 147 pp., illus., diagrams, charts, tables, $1.40. The beginning chapters of this textbook cover briefly the general topics of materials and their properties, stress analysis, tolerances, and fatigue. Although the conventional method of grouping the subsequent design material is generally followed, the simpler machine elements have been considered first to allow the subject to be studied concurrently with strength of materials. The new edition has been considerably revised in accordance with recent developments. A companion volume contains nearly 1200 problems illustrating points made by the text.

DYKE'S AUTOMOBILE AND GASOLINE ENGINE ENCYCLOPEDIA. By A. L. Dyke. Nineteenth edition. Goodheart-Willcox Co., Inc., Chicago, Ill., 1941. Cloth, 7 × 10 in., 1483 pp., illus., diagrams, charts, tables, $6. A remarkably comprehensive collection of information on automobiles and internal-combustion engines is presented in this manual for the use of students, repairmen, and owners. Topics covered include the principles, description and operation of all mechanical, propulsive, and electrical parts of an automobile, maintenance, testing and repair, specifications and definitions. There is new material on aircraft engines and their accessories, automotive Diesels, fluid drive, automatic transmissions, and other recent developments. A wealth of illustrations and ninety pages of general and supplementary index increase the utility of the book.

FLUID MECHANICS. By G. N. Cox and F. J. Germano. D. Van Nostrand Co., Inc., New York, N. Y., 1941. Cloth, 6 × 9 in., 274 pp., illus., diagrams, charts, tables, $3. This practical textbook on the behavior of fluids is intended to prepare engineering students for problems encountered in the industrial field, and covers both liquids and gases. The text is divided roughly into five parts: hydrostatics, measurement, transportation and dynamics of fluids, and centrifugal pumps. The necessary basic theoretical treatment is included, and there are many problems from actual practice.

HIGH-SPEED COMPRESSION-IGNITION ENGINE. By C. B. Dicksee. Blackie & Son, London, England, and Glasgow, Scotland; Interscience Publishers, New York, N. Y., 1940. Cloth, 6 × 9 in., 331 pp., illus., diagrams, charts, tables, $4.50. The principles governing the operation of high-speed compression-ignition engines are dealt with in detail, including discussions of associated problems. The early chapters present the fundamental chemical and thermodynamical theory. There is a particularly large chapter on fuel injection.

HIGH-SPEED INTERNAL-COMBUSTION ENGINE. By H. R. Ricardo, revised by H. S. Glyde. Interscience Publishers, New York, N. Y. Blackie & Son, Ltd., London, England, and Glasgow, Scotland, 1941. Cloth, 6½ × 10 in., 434 pp., illus., diagrams, charts, tables, $7.50. This comprehensive, authoritative work upon the characteristics and design of high-speed internal-combustion engines has been revised again to conform with current practice. There has been some addition and deletion in the standard material on engine design and fuel behavior, while other parts, the chapter on high-speed Diesels in particular, have been completely rewritten.

INDUSTRIAL FABRICS, a Handbook for Engineers, Purchasing Agents, and Salesmen. By G. B. Haven. Third edition. Wellington Sears Co., New York, N. Y., 1941. Fabrikoid, 5 × 8 in., 789 pp., illus., diagrams, charts, tables, $2. All phases of the cotton-fabric industry are covered in this handbook for engineers, purchasing agents, and textile students. In addition to the considerable amount of information on the raw material, manufacturing processes, and properties of fabrics, much space is devoted to specifications and test methods. There are many illustrations and tables, and the bibliography has been expanded.

Industrial Relations Digests. IV, JOB CLASSIFICATION AND EVALUATION. V, POLICIES IN THE ADJUSTMENT OF WAGE RATES. VI, BASIC TRAINING POLICIES. VII, SELECTION AND TRAINING OF FOREMEN. VIII, UPGRADING OF PRODUCTION WORKERS. Princeton University, Industrial Relations Section, Princeton, N. J., 1941. Paper, 7 × 10 in., 8 pp. each, tables, $0.20 each. These three pamphlets continue a series of digests prepared for use in companies facing rapid expansion because of defense orders. They are based on information received currently from a large number of representative companies.

INSTRUMENTS, Part 2. (Aeroplane Maintenance and Operation Series, Vol. 15.) Edited by E. Molloy and E. W. Knott. Chemical Publishing Co., Brooklyn, N. Y., 1941. Cloth, 5½ × 9 in., 132 pp., illus., diagrams, $2. Continuing a series on airplane maintenance and operation, this volume describes the operation, installation, and maintenance of the various instruments (indicators, compasses,

etc.) manufactured by the Kelvin, Bottomley and Baird Company. There is a long chapter dealing with the Smith automatic pilot, and a brief description of electrical temperature-measuring instruments is given.

MACHINE TRADES BLUEPRINT READING. By R. W. Ihne and W. E. Streeter. American Technical Society, Chicago, Ill., 1941. Paper, 9 × 11 in., 138 pp., blueprints, diagrams, charts, tables, $2. The first part of this book, which includes a glossary of shop terms, has been designed to teach all the basic information necessary to interpret a print. The rest of the book is composed of actual production blueprints, each of which is accompanied by a question sheet intended to bring out the important points embodied in the drawing.

MATERIALS OF INDUSTRY. By S. F. Mersereau, with an introduction by A. L. Colston. Revised and enlarged. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1941. Cloth, 5½ × 8½ in., 578 pp., illus., diagrams, maps, tables, $2. This textbook is intended to give students in technical and vocational high schools some knowledge of the main facts of industry, including the distribution and production of raw materials, their general properties, transportation, conversion into commercial products and economic importance. The principal products of forestry, mining, and chemical industry are described clearly and simply. Glossaries of terms and brief bibliographies are included.

MATHEMATICS FOR ENGINEERS. By R. W. Dull. Second edition. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1941. Cloth, 5½ × 8½ in., 780 pp., diagrams, charts, tables, $5. This work affords a convenient review of those phases of mathematics which are especially important in engineering work, and is intended for use as a practical reference work or as a text for private study. The chapter on the slide rule has been extended in this edition, and minor changes made throughout the text.

MATRIX AND TENSOR ALGEBRA for Engineers and Chemists. By C. E. Rose. Chemical Publishing Co., New York, N. Y., 1940. Cloth, 5½ × 8½ in., 143 pp., tables, $4. The object of this small volume is to present the elements of determinants, vectors, matrices, and tensors in such a way as to enable the physicist, chemist, or engineer to understand their application to technical problems. A knowledge of ordinary algebra and the differential calculus is assumed. Illustrative problems are freely used.

MECHANISM, Fundamental Theory of the Modification and Transmission of Motion. By S. E. Winston. American Technical Society, Chicago, Ill., 1941. Cloth, 5½ × 8½ in., 372 pp., illus., diagrams, charts, tables, $3.50. This book deals with mechanical movements and the combinations of links or machine elements by which these movements are modified and transmitted. The use of the graphical method for analyzing relative motions allows a simple mathematical treatment. Review questions and problems accompany each chapter.

METALLE UND LEGIERUNGEN FÜR HOHE TEMPERATUREN, Part 1. Zunderfeste Legierungen. (Reine und angewandte Metallkunde in Einzeldarstellungen, Vol. 2.) By W. Hessenbruch. Julius Springer, Berlin, Germany, 1940. Cloth and unbound, 6 × 9½ in., 254 pp., illus., diagrams, charts, tables, cloth 31.50 rm; unbound, 30 rm. Alloys which are resistant to scaling under high temperatures are discussed in this book, including the influence of various alloying elements and manufacturing processes. Important topics covered are the manner in which protective films or layers are formed and the reaction of heat-resistant metals to attack by various gases. A chapter is devoted to description of the special uses for which these scale-resistant alloys are suited, such as electric heating elements, spark plugs, etc.

MOLD-LOFT WORK, 2 parts. By A. C. Halliburton. International Textbook Co., Scranton, Pa., 1940. Cloth, 5 × 8 in., part 1, 82 pp.; part 2, 69 pp., diagrams, charts, tables, $2.15. The whole process of laying out a ship is covered in this practical, concise textbook. The many illustrations assist in demonstrating actual procedures. Equipment, materials and personnel are also briefly discussed.

MOTOR SHIP REFERENCE BOOK for 1941, compiled by the Staff of *The Motor Ship*, Temple Press, Ltd., London, England, E.C.1, 1941. Cloth, 5½ × 8½ in., 324 pp., illus., diagrams, charts, tables, 7s 6d net, or 8s post free. This annual publication on Diesel motor ships presents technical information on oil engines in general and on specific types, and contains an alphabetical list of all vessels completed to December, 1939, with a partial list for 1940. Lloyd's rules for the construction and survey of motor-ship machinery and a list of builders of marine Diesel engines in all countries are included.

NON-FERROUS PRODUCTION METALLURGY. By J. L. Bray. John Wiley & Sons, Inc., New York, N. Y., 1941. Cloth, 6 × 9 in., 430 pp., diagrams, charts, tables, $4. Intended as a basic college text, this book deals in alphabetical order with the nonferrous metals. It gives brief information about their history, economics, properties, marketing, uses, and ores, and the working essentials of production and refining practice. Space is also given to slags and fluxes, secondary metals, and the marketing of bullion, ores, and concentrates. Suggested references accompany each chapter.

Pennsylvania State College, Engineering Experiment Station Bulletin No. 54. OXYGEN-BOOSTING OF DIESEL ENGINES FOR TAKE-OFF, by P. H. Schweitzer and E. R. Klinge. State College, Pa., 1941. Paper, 6 × 9 in., 29 pp., illus., charts, diagrams, tables, $0.50. This pamphlet describes an investigation to determine the effect of feeding oxygen into the intake air of a Diesel engine. Results are given, and special reference is made to the use of this procedure in the case of airplane Diesels during take-off time when extra power is necessary for a few minutes.

PLANT-PRODUCTION DIRECTORY, Vol. 1, No. 1. First edition, 1941. Industrial Directories, Chicago, Ill. Cloth, 11 × 12½ in., 578 pp., illus., $10. The major part of this new industrial directory is devoted to an alphabetical listing of industrial products with the manufacturers of them. Other information given includes sources of supply for industrial chemicals, a large section of mathematical tables and mechanical data, a trade-name index, and a complete alphabetical list of manufacturers with addresses only.

PRACTICAL SHELL DEVELOPING FOR STEEL SHIPBUILDERS. By A. F. Tulin. Second edition. Simmons-Boardman Publishing Corporation, New York, N. Y., 1941. Cloth, 6 × 9½ in., 158 pp., illus., diagrams, charts, tables, $3. This manual for loftsmen, shipfitters, hull draftsmen, and others who deal with steel ship construction explains the development and laying-out of the shell of a vessel. Consideration is mainly given to the points of mold-loft procedure beyond the minor fundamentals, which are assumed as familiar.

PREVENTION OF THE FAILURE OF METALS UNDER REPEATED STRESS, a Handbook prepared for the Bureau of Aeronautics, Navy Department, by the Staff of Battelle Memorial Institute. John Wiley & Sons, Inc., New York, N. Y., 1941. Cloth, 6 × 9½ in., 273 pp., illus., diagrams, charts, tables, $2.75. Believing that lack of knowledge or appreciation of engineering principles among designers and builders of aircraft is responsible for many fatigue failures, this summary has been prepared. It brings together in convenient form the available information concerning the engineering principles involved in the precautions through which fatigue failures may be prevented, as they appear in published literature and the files of the Bureau of Aeronautics and the National Bureau of Standards. There is a good bibliography.

PRINCIPLES OF INLAND TRANSPORTATION. By S. Daggett. Third edition. Harper & Brothers, Inc., New York, N. Y., 1941. Cloth, 6 × 9½ in., 906 pp., illus., diagrams, charts, maps, tables, $4. Intended as a college text, this comprehensive work covers road, rail, water, air, and pipe-line transport, chiefly with respect to the United States. Early chapters present a brief historical survey and a consideration of transportation geography, Subsequent sections discuss rates, competition, labor and finance, relations of carriers with each other, and relations between carriers and users. The problems and practice of regulation have been given full consideration. This new edition has been thoroughly revised for current use.

PRINCIPLES OF INTERCHANGEABLE MANUFACTURING. By E. Buckingham. Second edition. Industrial Press, New York, N. Y., 1941. Cloth, 6 × 9½ in., 258 pp., illus., diagrams, charts, tables, $3. This treatise on the basic principles involved in successful interchangeable manufacturing practice has been reprinted from the earlier edition with minor changes in two chapters. It covers design, tolerances, drawings, manufacturing equipment, gaging, and inspection.

PROCEDURE HANDBOOK FOR AIRCRAFT STRESS ANALYSIS. By W. L. Nye, D. Hamilton, and J. P. Eames. Aviation Press, San Francisco, Calif., 1940. Paper, 7½ × 9¾ in., 334 pp., illus., diagrams, charts, tables, $4. This textbook was compiled to present as simple a treatment as possible on the subjects of strength of materials and stress analysis as applied to the present-day airplane. It deals with the fundamentals of aircraft stress analysis and presents examples which are currently encountered in conventional airplane-design work. Particular attention is given to the solution of beams by polar diagrams, the shell type of structure, and the theory of joints.

PSYCHROMETRIC NOTES AND TABLES. By E. Torok. Revised edition. North American Rayon Corporation, New York, N. Y., 1941. Leather, 5 × 7 in., 125 pp., charts, tables, $2.50. This handbook for textile manufacturers, engineers, and students presents the necessary information, accompanied by practical examples, for the solution of psychrometric problems. There is also a chapter containing tables of heat-transmission coefficients for building materials.

PUBLIC UTILITY ECONOMICS. By C. W. Thompson and W. R. Smith. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1941. Cloth, 6 × 9½ in., 727 pp., illus., maps, charts, tables, $4.50. Designed as a textbook for advanced students in economics and commerce, this book relates the

field of public utilities to the broader area of economics of which it is a part. Thus the book seeks to acquaint the student with the place which public utilities occupy within our economic structure, and with the special problems of price control, service supervision, security regulation, etc.

REFRIGERATION FUNDAMENTALS. By G. Holman. Nickerson & Collins Co., Chicago, Ill., 1940. Cloth, 6 × 9½ in., 175 pp., diagrams, charts, tables, $2. Written by an operating engineer for other operating engineers, this outline of refrigeration theory and practice begins with simple discussions about such physical phenomena as temperature, heat, pressure, and energy. Basic refrigeration processes are carefully described, and there are helpful practical suggestions on operating technique.

RELAXATION METHODS IN ENGINEERING SCIENCE, a Treatise on Approximate Computation. By R. V. Southwell. Clarendon Press, Oxford, England; Oxford University Press, New York, N. Y., 1940. Cloth, 6 × 9½ in., 252 pp., diagrams, charts, tables, $5. In this book, a new approach to engineering and physical computations is described, a method which is termed "systematic relaxation of constraints." The greater part of this treatise relates to problems confronted in the theory of elasticity: stress calculations for frameworks and continuous beams, estimation of critical loads, etc. However, the method is shown to have wider application, and such problems as the adjustment of errors in surveying and the determination of currents and potentials in electrical networks also receive detailed consideration.

REPORTS ON PROGRESS IN PHYSICS, Vol. 6, edited by J. H. Awbery, published by The Physical Society, London, England, 1940. Cloth, 7 × 10 in., 434 pp., illus., diagrams, charts, tables, 22s 6d. The present volume of this series follows the trend of the previous ones in devoting a still larger proportion of space to articles on the recent advances in such specific topics as the separation of isotopes, the cyclotron, the properties of liquid helium, superconductivity, impedance networks, etc. There are also general reviews of a few of the broader fields, such as sound and heat. Each article is the work of a specialist and has a bibliography.

RUBBER AND ITS USE. By H. L. Fisher. Chemical Publishing Co., Brooklyn, N. Y., 1941. Cloth, 5½ × 9 in., 128 pp., illus., diagrams, charts, tables $2.25. The constitution, properties, and history of naturally occurring rubber are discussed, with information upon where it comes from, how it is obtained, and how it is manufactured into various commercial articles. Recent developments in synthetic rubber are also covered. There is a list of reference works for supplemental reading containing brief descriptive notes.

RUNNING AN ENGINE LATHE. By F. H. Colvin. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1941. Cloth, 5 × 8 in., 117 pp., illus., diagrams, tables, $1.25. This is a practical manual for apprentices and young machinists in which the foundation principles of engine-lathe work are presented simply and clearly.

S.A.E. HANDBOOK 1941 Edition. Society of Automotive Engineers, New York, N. Y. Cloth, 5½ × 8½ in., 830 pp., illus., diagrams, charts, tables, $5 to nonmembers, $2.50 to members. All the current standards and recommended practices of the Society of Automotive Engineers concerning automobile and aircraft materials and parts, tests and codes, production equipment, nomenclature, and definitions are contained in this annually revised handbook. The numerous changes include new and revised standards, corrections, and cancellations. There is also a partial list of American standards of interest to the automotive industry.

SELECTION OF PRESSES. By S. D. Brootzkoos. Dryden Press, New York, N. Y., 1941. Cloth, 5½ × 8½ in., 111 pp., diagrams, charts, tables, $2. This work, which appeared serially in "The Modern Industrial Press," is intended to facilitate the selection of the proper type and size of press for a job. The theoretical principles governing the operation of mechanical and hydraulic presses are explained with directions and charts for determining the pressures required for the work and the actual and rated pressure capacities of presses.

SEPARATION OF GASES. By M. Ruhemann. Oxford University Press, New York, N. Y.; Clarendon Press, Oxford, England, 1940. Cloth, 6 × 9½ in., 283 pp., illus., diagrams, charts, tables, $5.75. The purpose of this treatise is to present a comprehensive review of the scientific and industrial aspects of gas separation. The author discusses the thermodynamic principles involved, and the recovery of argon, neon, and other gases from air, the recovery of helium from natural gas, the separation of coke-oven gas into its constituents, and the separation of olefins from cracker gas.

TABLES OF SINE, COSINE AND EXPONENTIAL INTEGRALS, Vol. 1. Prepared by the Federal Works Agency, Work Projects Administration for the City of New York, conducted under the sponsorship of the National Bureau of Standards, Washington, D. C., 1940. Cloth, 8 × 11 in., 444 pp., charts, tables, $2. The functions indicated are tabulated in this volume over the range from 0 to 2 at intervals of 0.0001. There are also supplementary tables, a bibliography of papers in which these functions have been applied to various technical problems, and lists of reference texts and of the best tables of the functions.

TABLES OF SINE, COSINE AND EXPONENTIAL INTEGRALS, Vol. 2, prepared by the Federal Works Agency, Work Projects Administration of the City of New York, conducted under the sponsorship of and for sale by the National Bureau of Standards, Washington, D. C., 1940. Cloth, 8 × 11 in., 225 pp., tables, $2, advance payment required. The functions indicated are tabluated in this volume over the range between 0 and 10 at intervals of 0.001. Differences have been listed for purposes of interpolation, although for the range from 0 to 2, vol. 1 should be consulted for greater accuracy in this respect. Several supplementary tables and various reference lists are included.

TECHNIK GESCHICHTE. (Beiträge zur Geschichte der Tecknik und Industrie, Band 28, 1939.) V.D.I. Verlag, Berlin, N.W. 7. Cloth, 8 × 11½ in., 188 pp., illus., diagrams, charts, tables, maps, 8 rm. The latest issue of this annual is generally devoted to the developments during the present century in various industrial fields. The advances in methods of testing materials, in iron smelting, bearings, electric furnaces, textile machinery, and hydraulic engineering are presented by specialists. Other papers discuss the development of belt transmissions, the history of alternating currents, and of electric meters, galvanic electricity, and mercury mining.

TECHNOLOGY AND SOCIETY, the Influence of Machines in the United States. By S. M. and L. Rosen, with an introductory chapter by W. F. Ogburn. The Macmillan Co., New York, N. Y., 1941. Cloth, 5½ × 9 in., 474 pp., illus., charts, tables, maps, $3. The interrelations between technology and the social scheme as they affect present-day life are presented in a simple, balanced manner. In addition to the four main sections, dealing respectively with the technologic base and economic, social, and political effects, there is a general introductory chapter and a final summing up. The book is intended particularly for undergraduate students. Suggestions for further reading are included.

TEMPERATURE MEASUREMENT. By R. L. Weber. Edwards Brothers, Inc., Ann Arbor, Michigan, 1941. Paper, 8½ × 11 in., 171 pp., illus., diagrams, charts, tables, $2.50. This book presents the substance of a course offered for juniors by the physics department of The Pennsylvania State College. Part 1 covers in a concise manner the theoretical basis for all the important methods of temperature measurement. Part 2 contains a comprehensive group of tested illustrative laboratory experiments. Literature references and review exercises are included.

VDI-Forschungsheft 404. UNTERSUCHUNG UND BERECHNUNG VON KÜHLWERKEN MIT HILFE DES i,t-BILDES. By J. Koch. V.D.I. Verlag, Berlin, Germany, 1940. Paper, 8 × 12 in., 22 pp., diagrams, charts, tables, 5 rm, (4.50 rm to members). The theoretical and practical use of the heat-content-temperature diagram in the investigation and calculation of refrigerating apparatus is discussed. Thermodynamical fundamentals are presented, various conditions are analyzed, and the setting up of representative curves is explained. Two large diagrams are included, and there is a bibliography.

VDI—Forschungsheft 405, FLÜSSIGKEITSBEWEGUNG IN UMLAUFENDEN RADIALRÄDERN. By E. Grünagel. V.D.I. Verlag, Berlin, Germany, December, 1940. Paper, 8 × 12 in., 21 pp., illus., diagrams, tables, 5 rm; 4.50 rm to members. This German research publication reports an investigation of fluid motion in rotating radial-turbine runners. The test equipment, models, and method of procedure are described, followed by a theoretical analysis of the results. There is a bibliography, and several plates containing flow photographs are appended.

WORLD AND THE ATOM. By C. Moller and E. Rasmussen, with foreword by N. Bohr. D. Van Nostrand Co., Inc., New York, N. Y., 1940. Cloth, 5½ × 9 in., 199 pp., illus., diagrams, charts, tables, $2.75. The development of modern atomic physics from the end of the last century to 1938 is briefly described for the layman. The major part of the book has been kept as simple as possible, and general physical concepts have been included wherever necessary. The book has been translated and revised from the original Danish, and is the product of the joint work of an experimental and a theoretical physicist.

WHEELER PROJECT. Technical Report No. 2 of the United States Tennessee Valley Authority, Knoxville, Tenn. Government Printing Office, Washington, D. C., 1940. Cloth, 6 × 9 in., 362 pp., illus., diagrams, charts, tables, maps, $1. A brief history of the Tennessee River development and the part played by the Wheeler project introduce this comprehensive report. The project investigations, including social and economic studies, the engineering design and construction work, initial operations, and reservoir adjustment are described. There is a complete summary of construction costs, and various special reports and test results are appended. A bibliography accompanies each chapter.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

Ordnance-Production Papers for A.S.M.E. Fall Meeting, at Louisville, Oct. 12–15

THE technical sessions of the A.S.M.E. Fall Meeting at Louisville, Ky., October 12–15, promise to be of exceptional interest to those in all branches of the profession. Ten divisional meetings are scheduled: Wood, Power, Fuels, Process, Aviation, Management, Metals, Safety, Oil and Gas Power, and Machine Shop.

Production of Ordnance Material

In this center of defense preparation, production of ordnance material will come in for its share of attention in the technical sessions, with papers on the induction heating and machining of shell casings, and a paper on the construction and operation of the huge Indiana Ordnance powder plant. In addition, the War Department has promised an exhibit of the various items now being manufactured in the Louisville area.

The complete program of the technical sessions will be announced in the September issue of MECHANICAL ENGINEERING.

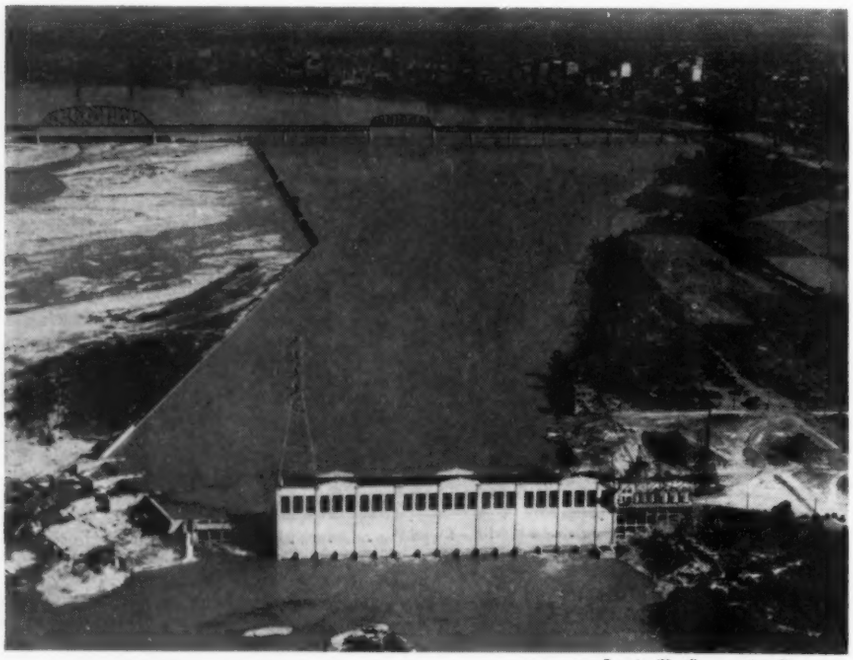
Registration will begin Sunday afternoon, October 12. On the Saturday preceding registration, meetings of the local section delegates of Group VI will be held.

Interesting Trips Planned

Plant trips already scheduled, to which the women attending the convention will be invited, include the Brown-Forman Distillery, a large cigarette-manufacturing plant, and the American Air Filter Co. where a new-type electrical precipitator will be demonstrated. In connection with the latter trip, the entire party will be taken to beautiful Churchill Downs, which is the scene of the famous Kentucky Derby.

On Thursday, October 16, the day after the convention closes, a motorcade to beautiful Mammoth Cave is scheduled for all those who stay over.

A woman's committee has been organized to insure that all the guests will enjoy their stay in Louisville. A complete program of trips, bridge, luncheons, and golf will be announced at a later date.



Louisville Convention League

HYDROELECTRIC POWER PLANT AT THE FALLS OF THE OHIO RIVER TO WHICH EXCURSION IS PLANNED DURING A.S.M.E. FALL MEETING AT LOUISVILLE

BROWN HOTEL, HEADQUARTERS FOR A.S.M.E. FALL MEETING AT LOUISVILLE

Dear "Mrs. A.S.M.E."

WE feel very privileged to have our turn at writing, "Please come too, when your husband attends the convention of the A.S.M.E." We are looking forward, indeed, to this opportunity of acquainting you first-hand with the hospitality that is tradition in Kentucky. Be assured you will have a good time.

There is so much worth seeing and doing in Louisville, or within easy distance of the city. Fort Knox, the beautiful Bluegrass section, the horse farms, and Mammoth Cave all offer unforgettable wonders. Kentucky has a special attraction for those who are sensitive to the glamour of the past. The Lincoln Shrine at Hodgensville, and the famous Old Kentucky Home at Bardstown are but two of the many attractions.

Already scheduled are several trips on which we shall accompany the men. While they are having their technical sessions, we plan to have a bridge party and luncheon. There will be golf, too, for all those who participate. For "nonbridgers" and nongolfers, there will be other entertainment that we feel certain will guarantee a pleasant time.

We want to assure you that at all times you will find some of us who are eager for a chat with you. We want you to visit us, and promise that you will have the best of times. So plan ahead now for those all important dates, October 12–15.

Sincerely,

Your Friends in Louisville

1942 A.S.M.E. Membership List Will Return to Alphabetical Arrangement

THOSE familiar with the directories of A.S.M.E. members issued prior to 1920 will recall that in most of them the alphabetical list of members contained the member's address and his grade and year of membership; the geographical grouping gave only the names of members in each locality. Then with the rapid development of Local Sections it was felt that the reverse arrangement would be more helpful and all issues from 1920 to 1940 carried the member's address and other information regarding him in the geographical section of the book, to which the alphabetical list of names served as an index.

During recent years, however, this arrangement has seemed to many to be less satisfactory than the original one. One reason for this is the increased number of members who are suburban residents. Those who work in one place and live in another, sometimes across the line in another state, have been placed under whichever geographical heading they preferred. Thus names one might expect to find under Chicago or Philadelphia or New York may be under any of the suburbs or places near-by those cities and frequently in other states. Consulting the alphabetical index to locate members involves considerable loss of time if many names are to be looked up.

The proposal that the early arrangement be restored has been discussed by the Committees on Local Sections and Publications and brought before conferences of the Local Sections Group Delegates. A study of comparative costs was made, and the decision finally reached to make such a change.

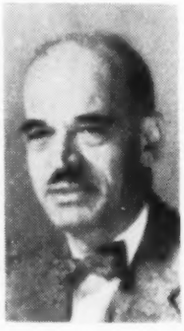
The alphabetical section of the 1942 directory, therefore, will give the member's name, followed by his grade and year of membership, symbols indicating registration in Professional Divisions, Society office held or award received, and his complete address, both business and residence, if he desires, with an indication as to which is to be used for mail, if he has a preference. The geographical section will give the names of those in each locality, and will show the Local Section to which each place is assigned.

All members will be given an opportunity to supply correct information for the new directory and also for listing in the Professional Service Index, a special section of the book for those engaged in professional engineering practice which was instituted in the 1940 issue. Because of slow mail service under the present war conditions, cards for this purpose have already been mailed to members in Europe, Asia, and Africa, to allow ample time for their receipt and return before the closing date of November 1. Other members, including all in the United States, will be sent cards at later dates.

As was announced in the July issue of MECHANICAL ENGINEERING, the directory will include only the names of those whose dues in full for the fiscal year beginning October 1, 1940, are paid by November 1, 1941.

Henry S. Harris Appointed Secretary Philadelphia Engineers' Club

HENRY S. HARRIS has been appointed secretary of the Philadelphia Engineers' Club to succeed William H. Sanford who died on April 29 of this year.



H. S. HARRIS

Mr. Harris was born in January, 1882, in New York City. He received his A.B. from Columbia University in 1902 and a B.S. in Ch.E. from the University of Pennsylvania in 1907. Upon graduation he entered the employ of the Westchester Lighting Company as cadet engineer. Subsequently he was connected with the Trenton Iron Works, the Tennessee Coal, Iron and Railroad Co., the H. R. Worthington Company, and the Cameron Pump Works of the Ingersoll-Rand Company. For the last several years he has been a member of the staff of The Franklin Institute in Philadelphia.

Mr. Harris is a member of the A.S.M.E. and long active in its work, and in response to the congratulations from his many friends, he bids them all welcome at the Engineers' Club, 1317 Spruce Street, Philadelphia, Pa.

J. L. Walsh Awarded Crozier Medal

COL. James L. Walsh, chairman A.S.M.E. Committee on National Defense, has been awarded the Gen. William Crozier gold medal for meritorious service to the Army Ordnance Association. Colonel Walsh was founder and first editor of *Army Ordnance*.

Marston Gets S.P.E.E. Lamme Medal

THE Lamme medal "for achievement in engineering education" was awarded to Anson Marston, dean emeritus and first to hold the position of dean of engineering at Iowa State College, at the 1941 meeting of the Society for the Promotion of Engineering Education, held at the University of Michigan, Ann Arbor, Mich., June 23–27, 1941. The citation reads: "To Anson Marston, for his leadership and service in the profession of engineering; for his vision and initiative in broadening engineering curricula; for his enterprise in guiding his students to a balance of engineering skill and artistic appreciation; for his foresight as a pioneer in the field of engineering extension; and for his untiring efforts in promoting closer cooperation between government and engineering colleges."

A. H. White Heads S.P.E.E.

AT the 1941 meeting of the Society for the Promotion of Engineering Education, held at the University of Michigan, Ann Arbor, Mich., June 23–27, A. H. White, of the University of Michigan, was elected president. Other officers are: H. T. Heald (member A.S.M.E.), Illinois Institute of Technology, and F. L. Eidmann (member A.S.M.E.) Columbia University, vice-presidents; J. H. Belknap, Westinghouse Electric and Manufacturing Co., N. W. Dougherty, University of Tennessee, A. C. Callen, Lehigh University, F. M. Dawson, University of Iowa, C. J. Freund (member A.S.M.E.), University of Detroit, S. Fairman (member A.S.M.E.), Purdue University, and R. P. Hoelscher, University of Illinois, members of council. W. O. Wiley (member A.S.M.E.) continues as treasurer, F. L. Bishop as secretary, and Nell McKenry as assistant secretary.

The 1942 meeting will be held in New York, June 29–July 2, and the 1943 meeting, which will be the Fiftieth Anniversary Meeting, in Chicago, with Northwestern University and Illinois Institute of Technology as hosts.

Brunnier Gets Marston Award

HENRY J. BRUNNIER, of San Francisco, Calif., has been awarded the Marston medal, highest honor of the Engineering Division of Iowa State College "in recognition of his exceptional ability as an engineer, his leadership in the promotion of international fellowship, his unfailing support of professional-engineering developments, the faithful discharge of his responsibilities to the United States, and his keen interest in civic affairs." Geo. A. Orrok, of New York, N. Y., represents The American Society of Mechanical Engineers on the Board of Award which selected Mr. Brunnier as the medalist for 1941.

Brown University to Continue Special Advanced Instruction and Research in Mechanics

BROWN University will continue during the academic year 1941-1942 the program of Advanced Instruction and Research in Mechanics which it is giving during the Summer Session, June 23–September 13, 1941, announced in the June issue of MECHANICAL ENGINEERING, page 492. Already thirty persons have asked to be enrolled for next year. Support will be solicited from the Engineering Defense Training Program of the U. S. Office of Education which has made a grant for the Summer Session. The Carnegie Corporation has made a grant to supplement other funds. Tuition fees are accordingly remitted for all participants; a few small fellowships are also made available.

The work during each of the semesters will parallel that of the Summer Session which is being held June 23–September 13. Further information may be obtained from the Dean of the Graduate School, Brown University, Providence, R. I.

PHOTOGRAPH TAKEN OF THOSE IN ATTENDANCE AT BANQUET HELD

A.S.M.E. Semi-Annual Meeting at Kansas City Has Well-Attended Sessions, Lively Discussion

FROM hopes to memories in four days! Or the story of the 1941 Semi-Annual Meeting in Kansas City.

Thus might one of the popular writers of yesteryear have titled the story of the Semi-Annual Meeting. Hopes, ideas, and work ran rampant for many, many weeks before the meeting. Now, we of the Kansas City Section relax in the comforting arms of sweet memories. Not that we could not have done a better job (things are so clear in retrospect!) but the assistance and cooperation of authors, executive staff, press, radio, Chamber of Commerce Convention Bureau, and those in attendance created an interesting and enjoyable meeting. We humbly thank each and every one of you!

"Opportunity Golden—Dividends Large!"

Those who could not attend will do well to read the published papers. Those who could but did not attend should read the papers but with an occasional twinge of remorse. The opportunity was golden and the dividends were large.

Statistics will not bring to you the real tenor of the meeting but a few may be of interest. Over 500 registered for the four-day meeting. There were from three to five simultaneous meetings plus the "Renewing Old Acquaintance" meeting near the registration desk. One must not forget the almost continuous meeting in Dining Room No. 2, temporarily A.S.M.E. headquarters, where missing data, information, and directions were supplied.

High Light Was the Banquet

The excellent papers speak well for the authors—but those not in attendance cannot realize the good times enjoyed by all at the luncheons and dinners. The high light was Wednesday night's banquet with senior and junior awards of the Spirit of St. Louis Medal and prize to Dr. Younger and Mr. Reaser. E. E. Howard, as toastmaster, truly set the tempo which was ably carried out by other speakers. The address of the evening, "Professional Engineering in a Democracy," by Dr. William McClellan, carried both humor and food for thought. Topping the evening was a most enjoyable dance.

It was a real pleasure to be host to such a fine group of visitors. We hope to see you all again—and real soon. In the meantime many of us hope to attend the Fall Meeting in Louisville, we want to hear (not hear about) the papers!

A. C. KIRKWOOD.

Spirit of St. Louis Medal Awarded to John E. Younger

A FEATURE of the banquet at the A.S.M.E. Semi-Annual Meeting, Kansas City, was the presentation of the Spirit of St. Louis Medal to John Elliott Younger, professor of mechanical engineering, University of Maryland. Notable contributions to the science of airplane design have been made by Professor Younger, particularly in the conception, analysis, and supervision of the development of the fundamental design principles, requirements, and criteria which first assured the success of the pressure-cabin type of high-altitude airplane. He has furthered aeronautics, as a teacher, for some years at the University of California, which has given him B.S., M.S., and Ph.D. degrees, and more recently at the University of Maryland; as the author of a number of books and many papers; as a consulting engineer to manufacturers in

SPIRIT OF ST. LOUIS MEDAL (OBVERSE)

DURING A.S.M.E. SEMI-ANNUAL MEETING AT KANSAS CITY

the airplane industry; and as an engineer in the service of the U. S. Air Corps.

By special invitation he lectured before the Royal Aeronautical Society in 1938, he is a Fellow of the Institute of the Aeronautical Sciences and a member of its Advisory Board, and other societies to which he belongs include the A.S.M.E., A.A.A.S., and S.P.E.E. He has traveled extensively in the United States, and abroad, familiarizing himself with aeronautical developments.

Presentation of Dr. Younger to the President of the Society was made by Samuel B. Earle, Vice-President, and the medal was bestowed by William A. Hanley, president. Following the simple ceremony Dr. Younger delivered an address, "Our Unused Potentialities for Aeronautical Research and Development," which appears in this issue.

Spirit of St. Louis Medal

The Spirit of St. Louis Medal was established by an endowment fund created by citizens of St. Louis in 1929 and donated to The American Society of Mechanical Engineers. It is given "for meritorious service in the advancement of aeronautics," and was named in recognition of the tremendous impetus given to the advancement of the aeronautical industry by the transatlantic flight of Charles A. Lindbergh in the "Spirit of St. Louis" in 1927. The medal is awarded at the discretion of the Council of the Society, upon the recommendation of its Board of Honors and Awards, at approximately three-year periods.

The obverse side of the medal depicts the emblem of the A.S.M.E., the globe and lever, together with the name of the recipient, the basic citation for the award, and the year of the founding of the medal. The reverse side shows Icarus, chosen by the artist, Victor S. Holm, as the figure to typify the Spirit of Flight, and beneath the Greek lettering for "Icarus," the date of Colonel Lindbergh's flight to Paris. The medal as presented is of gold, two and one-half inches in diameter.

Previous selections for the award were Daniel Guggenheim, Paul Litchfield, Will Rogers, and James H. Doolittle.

SPIRIT OF ST. LOUIS MEDAL (REVERSE)

Junior Award to W. W. Reaser

The Spirit of St. Louis Junior Award was conferred on Wilbur W. Reaser, Junior Member A.S.M.E., heating and ventilating engineer of the Douglas Aircraft Co., Inc., Santa Monica, Calif., for his paper "Calculation of the Heat Loss From an Airplane Cabin," following Professor Younger's address. Mr. Reaser was presented by R. L. Daugherty and President Hanley conferred the award.

Actions of A.S.M.E. Council at Kansas City Meeting

A MEETING of the Council of The American Society of Mechanical Engineers, which extended over four sessions, was held in the Muehlebach Hotel in Kansas City, Mo., June 15–16, 1941, in connection with the 1941 Semi-Annual Meeting. In addition to William A. Hanley, president, who presided, there were present: Samuel B. Earle, Francis Hodgkinson, and Frank H. Prouty, vice-presidents; Huber O. Croft, Paul B. Eaton, Joseph W. Eshelman, Linn Helander, Guy T. Shoemaker, and Willis R. Woolrich, managers; J. L. Kopf (Finance), H. L. Eggleston (Local Sections), C. B. Peck (Publications), S. R. Beitler (Constitution and By-Laws), and W. J. Wohlenberg (Meetings and Program), chairmen of standing committees; C. E. Davies, secretary; Ernest Hartford, executive assistant secretary; and the following guests: A. D. Bailey, E. J. Billings, W. G. Christy, R. L. Daugherty, H. E. Degler, N. C. Ebaugh, A. C. Kirkwood, F. W. Marquis, E. Mendenhall, E. W. O'Brien, W. W. Reaser, A. R. Stevenson, Jr., W. F. Thompson, and F. L. Wilkinson.

The following actions of the Council are of general interest:

Decision was reached to include in the 1942 Membership List (to be issued in February, 1942) only the names of members who, on Nov. 1, 1941, have paid up all dues for the fiscal year beginning Oct. 1, 1940.

Places and dates for coming national meetings were approved as follows: Spring Meeting, Houston, Texas, March 23–25, 1942; Semi-Annual Meeting, Cleveland, Ohio, June 7–11, 1942; Fall Meeting, Rochester, N. Y., Oct. 12–14, 1942.

Upon the joint recommendation of the Standing Committee on Power Test Codes and the Executive Committee on the Power Division, and with the understanding that the American Institute of Electrical Engineers has

ESTIMATED BUDGET FOR 1941-1942 ADOPTED BY THE COUNCIL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
JUNE, 1941

Activity	Expense under committee supervision	Printing and distribution	Direct office expense	Total
Council	$ 4,500.00	.....	.....	$ 4,500.00
Library	9,357.00	.....	.....	9,357.00
Finance Committee	115.00	.....	.....	115.00
Nominating Committee	700.00	.....	.....	700.00
Awards	550.00	.....	$ 332.80	882.80
Local Sections	27,503.00	.....	7,098.67	34,601.67
Meetings and Program	6,000.00	.....	4,280.36	10,280.36
Professional Divisions	2,700.00	.....	4,550.36	7,250.36
Admissions	.....	.....	7,190.62	7,190.62
Employment Service	2,000.00	.....	.....	2,000.00
Membership Development	2,500.00	.....	.....	2,500.00
Student Branches	11,800.00	6,300.00	4,605.19	22,705.19
Technical Committee	1,000.00	.....	19,708.00	20,708.00
Transactions	.....	35,500.00	12,387.50	47,887.50
MECHANICAL ENGINEERING, text	.....	29,000.00	10,411.50	39,411.50
Membership List	.....	3,500.00	3,118.00	6,618.00
MECHANICAL ENGINEERING, advertising	.....	21,100.00	23,486.66	44,586.66
A.S.M.E. Mechanical Catalog	.....	22,200.00	18,494.67	40,694.67
Publications for Sale	.....	27,000.00	9,403.67	36,403.67
Reserved for Boiler Code	.....	4,000.00	.....	4,000.00
Membership List Advertising Pages	.....	200.00	.....	200.00
Retirement Fund	7,700.00	.....	.....	7,700.00
E.C.P.D.	850.00	.....	.....	850.00
General committee expense	100.00	.....	.....	100.00
Professional services	1,150.00	.....	.....	1,150.00
Committee on Registration	250.00	.....	.....	250.00
Washington Office	1,000.00	.....	.....	1,000.00
Secretary's Office	.....	.....	18,445.00	18,445.00
Accounting Department	.....	.....	14,878.00	14,878.00
General service	.....	.....	27,176.00	27,176.00
General office expense	.....	.....	16,333.00	16,333.00
	$79,775.00	$148,800.00	$201,900.00	$430,475.00

ESTIMATED INCOME FOR 1941-1942 ADOPTED BY THE COUNCIL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
JUNE, 1941

Income	Actual 1939-1940	Budget 1940-1941	Estimate 1941-1942
Initiation and Promotion Fees (to Surplus)	$ 9,155.64	$ 7,500.00	$ 8,000.00
Membership dues	217,382.04	216,000.00	220,000.00
Student dues	20,420.55	20,400.00	21,000.00
Interest and discount	10,609.36	10,000.00	10,000.00
MECHANICAL ENGINEERING, advertising	79,551.82	79,000.00	84,000.00
Mechanical Catalog, advertising	41,551.10	41,500.00	42,500.00
Publication sales	55,793.16	65,500.00	59,000.00
Miscellaneous sales	1,619.10	1,500.00	1,500.00
Contributions, *Journal of Applied Mechanics*	1,350.00	.....	.....
Engineering Index, Inc	564.24	495.00	495.00
Registration fees	287.00	426.00	425.00
Sale of equipment	82.50	100.00	100.00
Membership List Advertising	668.00	.....	600.00
Total income	$429,878.87	$434,921.00	$439,620.00
To be added to surplus	16,765.31	6,743.00	9,145.00
Balance for expense	$413,113.56	$428,178.00	$430,475.00

taken corresponding action, the Council authorized appointment of a joint A.S.M.E.-A.I.E.E. committee for the purpose of drafting a recommended specification covering speed regulation of prime movers for electric generators.

Upon recommendation of the Board on Technology the Council adopted a policy of maintaining a balanced program of national meetings, papers, and publications. To carry this out, the program of national meetings and the number of papers to be presented thereat, shall not be determined until the effect on the publications' budget has been evaluated. The program shall be so established that a satisfactory proportion of the papers presented may find their places in the publications of the Society.

The 1941-1942 Budget, as printed on this page, was adopted.

Mr. Hodgkinson reported that the Metropolitan Section has used surplus funds secured as a result of its educational program to establish a Student Loan Fund for engineering students whose fathers are members of the Metropolitan Section. This fund is to be administered by a Board consisting of R. L. Sackett, chairman, W. H. Larkin, 3rd, secretary, F. M. Gibson, Francis Hodgkinson, and W. A. Shoudy.

Further details will be found on page 622 of this issue.

To the Committees!

MEETINGS just don't happen—a *lot* of work is required to round out the details and for many weeks the men and women who handled the Semi-Annual Meeting in Kansas City devoted much of their time to work on arrangements and schedules.

To these committee workers go the thanks of everyone who attended the Convention—"one of the best-handled" was the opinion of many who reported to A.S.M.E. headquarters. Mr. Kirkwood modestly omits mention of what a really fine committee job was done to make the 1941 Semi-Annual Meeting in Kansas City a memorable one.

Committees

LINN HELANDER, *General Chairman*
E. L. MCDONALD, *Vice-Chairman*
H. L. CRAIN, *Chairman, Kansas City Section*
JOHN LYLE HARRINGTON, *Honorary Chairman*

Advisers

ALBERT L. MAILLARD
HAROLD A. SMITH
RAYMOND P. HAHN (*Junior Representative*)

Honorary Committee From Local Sections

Chicago, L. M. ELLISON, R. E. TURNER
Colorado, F. H. PROUTY, R. F. THRONE
Kansas City, H. L. CRAIN, E. D. HAY
Mid-Continent, E. C. BAKER, D. B. HUTCHCRAFT
Nebraska, J. W. HANEY, A. A. LUEBS
New Orleans, L. J. LASSALLE, J. M. TODD
North Texas, R. M. MATSON
St. Louis, HERBERT KUENZEL, ALBERT VIGNE
South Texas, C. W. CRAWFORD

Subcommittees

Technical Events

J. A. KEETH, *Chairman* N. W. DOWNES
F. R. APPLEGATE JACK WEISBEIN

Distinguished Guests

G. T. SHOEMAKER, *Executive Chairman*
J. L. HARRINGTON, E. E. HOWARD } *Associate Chairmen*
H. L. CRAIN H. J. HENRY

Hotels

R. V. SUTHERLAND, *Chairman*
L. S. BROOKS M. A. DURLAND
F. O. DOUGHTY T. J. ESSEX

Plant Trips

H. A. ATWATER, *Chairman*
T. C. CHEASLEY NEWBY MILLER
R. P. HAHN C. Q. WARD

Entertainment

F. J. Holzbaur, *Chairman*
G. G. Brauninger — W. L. Mathews
L. W. Browne — H. A. Smith
A. J. Mack — W. E. Widau
R. S. Tait

Publicity

A. C. Kirkwood, *Chairman*
S. A. Hadley — R. O. Joslyn
P. L. Stolz

Printing and Signs

N. W. Downes, *Chairman*
H. L. Brown — W. H. Lebo
Harold Grasse — H. W. Williamson

Finance

J. R. Stone, *Chairman*
Chester Cotter — A. C. Flinner
J. A. King

Information—Registration—Reception

J. F. Pritchard, *Chairman*
C. E. Beck — M. H. Dean
B. B. Brainard — H. E. Manuel
C. E. Brown — H. R. Orth
E. M. Bruzelius — W. G. Ransom
Harry Darby — A. H. Sluss
Walter Springe

College Participation

W. B. Rollins, *Executive Chairman*
A. S. Langsdorf, *Associate Chairman*
F. G. Baender — E. D. Hay
E. C. Baker — R. O. Joslyn
R. M. Barnes — E. N. Kemler
W. H. Carson — O. A. Leutweiler
M. P. Cleghorn — R. G. Paddock
M. A. Durland — J. E. Schoen
B. G. Elliott — R. A. Scorah
J. W. Haney — L. C. Straub
W. R. Woolrich

Women's Events

Mrs. F. J. Holzbaur, *Chairman*
Mrs. H. A. Atwater — Mrs. J. A. Keeth
Mrs. C. E. Brown — Mrs. W. L. Mathews
Mrs. Linn Helander — Mrs. J. F. Pritchard
Mrs. R. O. Joslyn — Mrs. G. T. Shoemaker

A.S.M.E. Applied Mechanics Division Joins With Heat Transfer Division and A.S.C.E. in Eighth Annual Meeting, Philadelphia

THE University of Pennsylvania and the Philadelphia Local Section of The American Society of Mechanical Engineers were hosts to the eighth National Meeting of the Applied Mechanics Division on June 20 and 21, the A.S.M.E. Heat Transfer Division and the committee on applied mechanics of the Structural Division of the American Society of Civil Engineers cooperating in joint sessions. Although the national-defense program necessitated the absence of some members, including the chairman of the Applied Mechanics Division, J. P. Den Hartog, and the research secretary, J. Ormondroyd, both of whom are on active duty in the United States Navy, the sessions were well attended and the discussion was lively.

Heat Transfer Division Contributes

Thomas B. Drew, past chairman of the Heat Transfer Division, presided at the first session held jointly with that division. H. W. Emmons described the further studies made by J. G. Brainerd and himself on the effect of the variation of viscosity on the compressible boundary-layer flow around a flat plate. The results, made possible by the use of a differential analyzer, are of interest to engineers using plate thermometers for making temperature measurements in high-speed air streams and to those concerned with drag and heat flow at high speeds under conditions of laminar flow.

Victor Paschkis described an electrical device developed by himself and H. D. Baker at Columbia University for solving unsteady-state heat-transfer problems by means of an electrical analogy. The device is applicable to the study of problems arising in the intermittent heating of buildings, pipe lines, and furnace walls, and in the heat-treatment of metals.

J. A. Goff presented a paper by J. H. Hunter and himself on the effect of departures from Dalton's law on the determination of latent heat by the gas current method. He called attention to the importance of the so-called "interaction constant" in computations involving the thermodynamics of mixtures of water vapor and air. Prof. C. A. Shook of Lehigh University gave a remarkably lucid presentation of H. L. Langhaar's paper on the flow in the transition length of a cylindrical conduit, a theoretical treatment of the problem giving detailed velocity distributions at various sections as well as over-all pressure drop and the "kinetic-energy correction" familiar in viscometry.

Elasticity and Plasticity

J. N. Goodier presided at the second session devoted to elasticity and plasticity. M. V. Barton presented the theory of clamping stresses or stresses associated with shrink fits, more exactly the stresses in a circular cylinder with a band of uniform pressure on a finite length of the surface. J. J. Stoker described an exact solution by K. O. Friedrichs and himself of the equations for the buckling of the circular plate beyond the critical thrust under conditions of radial symmetry. This paper aroused much discussion of the relation between the theoretical solution and the actual behavior of a plate under the assumed loading. M. A. Sadowski showed how the sand-heap analogy in problems of plastic torsion could be extended to cross sections having one or more holes. This method was compared to analytical and graphical methods in the discussion.

Vibration Problems

The third session, under the chairmanship of C. R. Soderberg, dealt with vibration problems. W. M. Dudley discussed the application of difference equations to the analysis of the longitudinal motions of cars in long trains. An interesting discussion followed as to the application of the results to actual trains and as to the relation between difference equations and differential equations. In the second paper C. A. Meyer gave an account of work by himself and H. B. Saldin on the application of model tests to vibration dampers for turbine blades. The beautifully simple dampers un-

AT THE ANNUAL DINNER OF THE A.S.M.E. APPLIED MECHANICS DIVISION

doubtedly have other possible applications in rotating machinery, and the performance obtained was remarkable. N. Minorsky read a valuable paper dealing with the theory of the hunting of control systems in which there are unavoidable time lags. Though the treatment was restricted to systems governed by linear differential equations, such systems occur frequently in practice.

A.S.C.E. Takes Part

The final session was held jointly with the A.S.C.E. committee on applied mechanics, J. A. Van den Broek presiding. N. M. Newmark described approximate procedures for calculating deflections and moments in beams and columns which are more easily applicable than the use of differential equations. C. O. Dohrenwend and Bruce G. Johnston in separate papers discussed the stresses in deep beams and columns, respectively, under eccentric loading. Such problems arise, for example, in the design of beams for shop cranes.

At a luncheon meeting of the Executive Committee on Friday, plans were discussed for participation in the Annual Meeting of the Society in December. At 4:30 p.m., the Executive Committee held an informal meeting with the A.S.C.E. committee on applied mechanics to discuss matters of mutual interest, in particular, methods of greater cooperation in the future.

England at War Described by Yarnall

At the dinner on Friday morning, D. Robert Yarnall, fellow A.S.M.E., vice-president of the American Friends' Service Committee, vividly recounted his experiences in visiting England in January, February, and March, of this year, and sketched a picture of life in England at war. John A. Goff, Dean of the Towne Scientific School and director of the department of mechanical engineering, University of Pennsylvania, was toastmaster.

The 22 ladies present participated in a special program of visits arranged by the ladies committee, Mrs. J. A. Goff, chairman, and also attended the dinner.

A.S.M.E. headquarters was represented by G. B. Karelitz of the Standing Committee on Professional Divisions.

Those attending are especially grateful to the University of Pennsylvania, the A.S.M.E. Philadelphia Section, and to the local committees for their hospitality.—H. P. DRYDEN.

A.S.M.E. Calendar

of Coming Meetings

October 12–15, 1941
Fall Meeting
Louisville, Ky.

October 30–31, 1941
Joint Meeting of A.S.M.E. Fuels and A.I.M.E. Coal Divisions
Lafayette College
Easton, Pa.

December 1–5, 1941
Annual Meeting
New York, N. Y.

March 23–25, 1942
Spring Meeting
Houston, Texas

(*For coming meetings of other organizations see page 18 of the advertising section of this issue*)

A.S.M.E. Metropolitan Section Establishes Student Loan Fund

ACCORDING to an announcement made by Francis Hodgkinson to the Council of The American Society of Mechanical Engineers at its meeting in Kansas City, June 15 and 16, the A.S.M.E. Metropolitan Section has established a Student Loan Fund out of unexpended receipts for fees collected in connection with its educational courses for Junior members. The loan fund is to be used for the aid of engineering students who are sons of members of the A.S.M.E. Metropolitan Section and who are already matriculated in an accredited engineering curriculum. Undergraduate and postgraduate students may apply.

Conditions under which loans are made have been posted to all members of the Metropolitan Section, with application blanks. The rules provide that the amount of each loan will be limited by the number of qualified applicants; that loans will not be made for amounts less than $100 or more than $300 per year; that the board administering the loan will not commit itself in advance for periods longer than one year; and that the loans will be covered by a note, with interest at 2 per cent per annum, and maturing one year after graduation. Repayments of loans may be made in installments of not less than $25 each. Applications for loans must be submitted not later than July 1 of each year. (For this year, the board will accept applications until August 15, or even a little later if necessary, as application forms could not be mailed until late in June.)

The loans will be administered by a Board consisting of R. L. Sackett, chairman, W. H. Larkin, 3rd, secretary, F. M. Gibson, Francis Hodgkinson, and W. A. Shoudy.

A.S.A. Announces Standard on Accuracy of Engine Lathes

THE American Standards Association has announced publication of a new standard setting up requirements for Accuracy of Engine Lathes. Approval of the standard under the Association's new Emergency Procedure was announced in May.

The new standard provides a series of 25 tests to be applied in checking engine lathes for accuracy. These include tests for bed level, tailstock way alignment, spindle-center runout, cam action, lead-screw alignment, and turning work round or cylindrical when mounted in chuck or between centers. The accuracy requirements, stated in terms of maximum permissible variations apply to three groups of engine lathes: toolroom lathes; engine lathes, 12 to 18 in., inclusive; and engine lathes, 20 to 36 in., inclusive.

This standard was developed by the Engine Lathe Group of the National Machine Tool Builders' Association and has already proved its value in practice, for example, in machine-tool purchases made by the government. The National Machine Tool Builders' Association submitted the standard to the American Standards Association for approval and asked that it be handled under the A.S.A. Emergency Procedure to speed up its publication.

Copies of the new standard, Accuracy of Engine Lathes (B5.16–1941), are now available from the American Standards Association, 29 West 39th St., New York, N. Y., at 25 cents.

Industrial Accident-Prevention Signs Standard Issued

A NEW standard for industrial accident-prevention signs which provides for uniform colors and wording is announced by the American Standards Association. Its purpose is to increase the effectiveness of safety signs in preserving human life.

For maximum safety, it should not be necessary to stop, read, and analyze the meaning of each particular warning sign. Reaction to such signs should be automatic, particularly in workplaces where employees cannot read English readily but can be trained to recognize instantly and be warned by standard sign designs and colors.

Five Major Groups

It is with this thought that the committee developing the standard has divided all accident-prevention signs into five major groups:

(1) Danger signs to be used to warn about specific dangers only and removed as soon as the danger they warn against no longer exists.

(2) Caution signs used to warn against possible danger or unsafe practices.

(3) Safety instruction signs providing information regarding general safe practices.

(4) Directional signs used to point the way to staircases, fire escapes, exits, etc.

(5) Informational signs to carry messages of a general nature as rules and regulations.

The standard sets forth the best current practice in color, design, application, and use of all accident signs classified in these five groups.

This standard does not mean that all signs in use should be replaced immediately with standard signs. The committee developing the standard, however, hopes that all new signs and replacements of old signs will be designed and constructed in accordance with these specifications. Thus, in time the accident-prevention signs used by all industry will be the same and employees no matter where they work will recognize the same familiar designs and colors with their definite meanings.

May Be Purchased From A.S.A.

American Standard Specifications for Industrial Accident Prevention Signs, Z35.1–1941, has been published in pamphlet form and is now available at 35 cents from the American Standards Association, 29 West 39th Street, New York, N. Y.

Socket-Welding-Fittings Standard Sent Out for Comment

Resulting Criticism Will Be Submitted to Committees Concerned

PAGE-proof copies of the Proposed American Standard for Socket Welding Fittings, which covers the range from $^3/_8$ in. to 3 in. nominal pipe sizes, have been submitted for comment to all members of A.S.A. Sectional Committee B16 and to about 100 firms representative of industry or concerned with the manufacture or use of the product. Other persons interested in the proposed standard and wishing to comment on it will be mailed proof copies on request to The American Society of Mechanical Engineers. Criticism should be mailed to the A.S.M.E. and will be considered by the various committees concerned and incorporated where practicable in a revised draft.

Work Started in 1938

According to Sabin Crocker, chairman of Subgroup No. 6 on Standardizing the Dimensions of Welding Fittings, socket welding fittings first appeared on the market as a commercial article about 1934, although fittings of this sort had been tried out by the U. S. Navy at least as early as 1928. By 1938 confusion arising from the variety of dimensions in which the product was supplied had reached proportions which led to a request for its standardization being entertained by A.S.A. Sectional Committee B16. In view of the generally recognized need for establishing standard dimensions, the project was referred by the Sectional Committee to its Subcommittee No. 3 which organized a Subgroup No. 6 on Welding Fittings and called a meeting of those interested in December, 1938. Owing, however, to discordant dimensions which necessitated changes in manufacturing equipment by several manufacturers before an interchangeable product could be offered, some time has been required to effect satisfactory compromises and formulate a proposed standard for submission to Sectional Committee B16 and industry for acceptance.

Three Possibilities Considered

In settling on a generally acceptable basis for over-all dimensions the following possibilities were considered:

(*a*) Center line of fitting to bottom of socket.
(*b*) Center line of fitting to end of pipe used with fitting.
(*c*) Center line of fitting to outboard end of socket.

After much discussion, possibility (*a*) was settled on as the most logical, since from the standpoint of the user this dimension governs the location of the fitting with reference to the entire piping layout. Difficulty in arriving at a standard dimension for center to bottom of socket due to differences in existing manufacturing practice was the occasion for considering possibilities (*b*) and (*c*). Neither of these alternatives was deemed a satisfactory substitute, however, since gaging and inspection would be awkward for (*b*), while (*c*) failed to establish for the user a length of pipe suiting different brands of fittings having varying depths of socket.

Hence it was finally agreed, at the expense of having to discard some manufacturing equipment, to standardize on the center line of fitting to bottom of socket as the basic dimension and let the end of the socket extend over the pipe by varying amounts corresponding to the depth of socket desired by the individual manufacturers. Although the depth of socket, within reasonable limits, was considered unimportant by most users, considerable manufacturing equipment and some sales effort had been devoted by certain manufacturers toward furthering shallow or deep sockets according to their individual preferences.

Adoption of the center line of fitting to bottom of socket principle was coupled with a proviso that the sockets must be at least as deep as the minimum dimension prescribed in Par. 7 (*b*) of the proposed standard. This left the way open to accommodate the preferences of those manufacturers who advocated some particular depth of socket, and at the same time made all brands of fittings interchangeable from the users' standpoint. Incidentally, for any given pipe size, all weights of fittings, viz., schedules 40, 80, and 160, have the same dimensions for diameter of socket bore, for center of fitting to bottom of socket (except for 45-deg elbows), and for minimum depth of socket. As might be expected this leaves only the wall thicknesses of fitting and socket, and the bore diameter of the fitting proper, to vary with the schedule number.

It is intended that socket welding fittings shall be as strong as the corresponding pipe of the designated schedule number. The wall thickness of fittings must be equal to or greater than the wall thickness of the designated pipe schedule. (See Fig. 1 which is reproduced from the standard.) Rules for establishing the strength, and indirectly the metal thickness, of fittings through test of pilot fittings are set forth in detail in Par. 6 of the proposed standard.

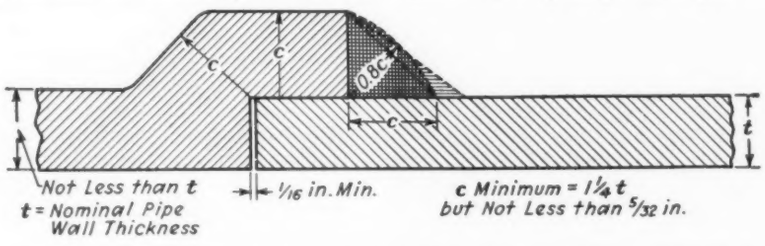


FIG. 1 MINIMUM REQUIREMENTS FOR SOCKET- AND FILLET-WELD DIMENSIONS

According to Par. 5 of the proposed standard, the material of wrought fittings shall be in accordance with A.S.T.M. Specification A234, and of cast fittings in accordance with A.S.T.M. Specification A216 for welding-grade carbon cast steel or A217 for welding-grade alloy cast steel. In this standard "wrought" is used to denote fittings made of pipe, tubing, or forgings.

Routine hydrostatic testing of wrought welding fittings is not required by the proposed standard, although on special agreement they can be tested according to rules laid down in Par. 8. All cast welding fittings must be tested as provided in A.S.T.M. Specification A216 or A217.

As stated in Par. 6 of the proposed standard, however, the actual bursting strength of each manufacturer's line of fittings must be determined in advance of going on the market through hydrostatic tests on pilot fittings of each size, schedule, and type. To insure adequacy of fitting design, the actual bursting strength of fittings must be demonstrated to equal the computed bursting strength of pipe of the designated schedule number and material.

Standard Reference Cutting Oil Available

To Create Yardstick Between Laboratory and Shop Practice

THE Independent Research Committee on Cutting Fluids, A.S.M., headed by Joseph Geschelin, chairman, with the cooperation of the A.S.M.E. Special Research Committee on Cutting Fluids, O. W. Boston, chairman, developed a reference cutting oil which is being distributed to members of these committees for evaluation. The purpose of this reference cutting oil is to create a workable yardstick between laboratory and shop practice, as well as a basis for comparison of cutting oils, metals and their machinability, and machining operations.

This reference oil was selected by the committee as the first step in the correlation program. Any organization interested in participating in this program can do so. The reference cutting oil can be procured by writing to H. L. Moir, The Pure Oil Company, Winnetka, Ill.

The committee requests those interested to procure a sample of this oil, and evaluate it on whatever means at their disposal, whether it be laboratory machines, or practical tests in the shop. Shop tests can be on machinability, tool life, finish, or any other criterion used by the participant.

All of the contributed material will be grouped and studied, and a correlation report given to those participating in the work. When the program is finished, the committee hopes to have an understandable correlation between shop and laboratory practice which will be of use to all participants as a cutting-oil standard.

James W. Parker

Nominated for President

A.S.M.E. OFFICERS *Nominated for* 1941-1942

DURING the 1941 Semi-Annual Meeting of The American Society of Mechanical Engineers in Kansas City, Mo., June 16–19, James W. Parker, vice-president in charge of engineering of The Detroit Edison Company, Detroit, Mich., was nominated by the National Nominating Committee for the office of President of the Society for the year 1941-1942.

Vice-Presidents named by the Committee to serve two-year terms on the Council of the A.S.M.E. were Clarke F. Freeman, Providence, R. I., Clair B. Peck, New York, N. Y., William H. Winterrowd, Eddystone, Pa., and Willis R. Woolrich, Austin, Texas.

Managers of the Society to serve on Council for three-year terms included William G. Christy, Jersey City, N. J., Herbert L. Eggleston, Los Angeles, Calif., and Thomas S. McEwan, Chicago, Ill.

Members of the committee who were in attendance at Kansas City and made the nominations were: A. L. Kimball, Schenectady, N. Y., chairman, representing Group III; E. J. Billings, New York, N. Y., vice-chairman, Group II; N. C. Ebaugh, Gainesville, Fla., secretary, Group IV; W. F. Thompson, New Haven, Conn., Group I; H. B. Joyce, Erie, Pa., Group V; R. E. Turner, Chicago, Ill., Group VI; Earl Mendenhall, Los Angeles, Calif., Group VII; and L. J. Lassalle, University, La., Group VIII.

Election of A.S.M.E. officers for 1942 will be held by letter ballot of the entire membership, closing on Sept. 23, 1941. A ballot will be mailed to every member in good standing about August 21.

Biographical sketches of the nominees follow on the succeeding pages:

Nominated for President

James W. Parker

JAMES WENTWORTH PARKER, nominated for President of The American Society of Mechanical Engineers, is vice-president and chief engineer of The Detroit Edison Company, and has his residence in Ann Arbor, Michigan. He was born in Auburn, New York, in 1886, of people who had lived in that state for a generation or more but had originally come from New England. His family moved to Kentucky when he was four years old and his boyhood was spent in Louisville.

He prepared for college in the Louisville Male High School and was graduated from Cornell University in 1908, with the degree of mechanical engineer. In 1935 he was awarded the honorary degree of master of science in mechanical engineering by the Detroit Institute of Technology. He is a member of the honorary societies of Sigma Xi and Tau Beta Pi.

After graduation from Cornell, Mr. Parker served an apprenticeship, first with the DeKalb Power & Light Company in Illinois, and then with the Vincennes Street Railway Company, Vincennes, Ind. In 1910 he moved to Detroit to become boiler-room engineer with The Detroit Edison Company, and has been employed continuously by that Company to the present time, with the exception of a year's leave of absence for war service in 1918.

In the course of this employment he has organized and directed the various engineering projects which his company has accomplished in the last twenty years, notably the design and construction of its electric power plants, Trenton Channel, Marysville, Delray No. 3, and Conners Creek. In addition to supervising new construction, Mr. Parker has also general responsibility for the operation of The Detroit Edison electrical system and of its generating plants, and central-heating plants and system.

During the first World War he served in the Nitrate Division of the Ordnance Department, United States Army, as consulting mechanical engineer and head of that Division's inspection section.

He served ten years as a Trustee of Cornell University, elected by the alumni in 1929 and re-elected in 1934.

Mr. Parker has been a member of The American Society of Mechanical Engineers since 1913. From 1928 to 1933 he served as member of the Committee on Meetings and Program, and as Manager from 1935 to 1938, and Vice-President from 1938 to 1940. He served as a member of the Society's executive committee for four years.

He has just served a three-year term as president of the Engineering Society of Detroit, having been a director since the organization of the new society in 1936; and is a member of the Michigan Engineering Society and the Prismatic Club of Detroit.

Nominated for Vice-Presidents

Clarke F. Freeman

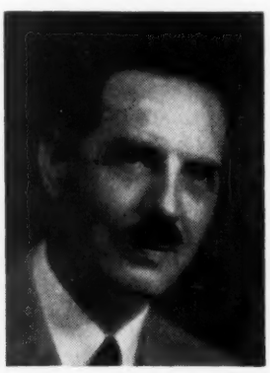
CLARKE FARWELL FREEMAN, nominated for Vice-President of The American Society of Mechanical Engineers, was born in Winchester, Mass., June 1, 1890, his father being John Ripley Freeman, president of the Society in 1905. After receiving his A.B. degree from Harvard University in 1912, he completed a year of graduate work at Lawrence Scientific School.

In 1913, he started his engineering career as an industrial engineer with the Remington Typewriter Company where he installed the Gantt system of scientific management. After two years there, he left to become plant engineer of the Boston Insulated Wire and Cable Company. In 1916 he became connected as mechanical engineer with the Allied Machinery Company, in charge of machine tools on war contracts, and later was sent to France to set up machines and instruct the workmen in their operation. With the entrance of the United States into the war, he became an engineer in the Ordnance Department, where his duties concerned the adapting of English and French war pieces to the use of the American Army, with particular reference to fuses, grenades, trench mortars, and other material. From July, 1918, he was responsible for the maintenance and supply of all small arms and trench-mortar ammunition for the First Army, A.E.F.

Upon his return to this country after the War, he returned to his position as mechanical engineer with the Allied Machinery Company. Then in 1921, he became a field engineer for the Manufacturers Mutual Fire Insurance Company, and in 1932 was appointed senior vice-president and engineer of the company, and its associated companies, The Rhode Island Mutual Fire Insurance Co., State Mutual Fire Insurance Co., Mechanics Mutual Fire Insurance Co., Enterprise Mutual Fire Insurance Co., and The American Mutual Fire Insurance Co., the position which he now holds.

He became a member of the Society in 1915 and since has been most active, not only within his own local section, but also in committee work of the Society at large. He served as member and chairman of the Meetings and Program Committee to which he was appointed in 1933. Mr. Freeman acted as editor of the American translation from the German of Armin Schoklitsch's "Hydraulic Structures." He similarly acted in the publishing of John R. Freeman's original experiments on the "Flow of Water in Pipes and Pipe Fittings." In 1936, he served as president of the Providence Engineering Society. As Manager of the Society he has been a Member of its Executive Committee for the last three years.

C. B. PECK



W. R. WOOLRICH

C. F. FREEMAN

W. H. WINTERROWD

Clair B. Peck

CLAIR B. PECK, managing editor, *Railway Mechanical Engineer*, who has been nominated for the office of Vice-President of The American Society of Mechanical Engineers, was born at Pierson, Mich., June 24, 1884, and was educated in the public schools of Belding, Mich., and the Michigan Agricultural College, where he was graduated with the degree of B.S. in mechanical engineering with the class of 1907. He is a member of Tau Beta Pi honorary society.

Mr. Peck entered railway service, upon graduation, as a draftsman at Marquette, Mich., for the Duluth, South Shore, and Atlantic Railway. In 1911 he entered the mechanical-engineer's office of the Atchison, Topeka, and Santa Fe Railway, at Topeka, Kan., where special assignments afforded him wide experience in standardization, stores control, and locomotive performance.

It was during this period that Mr. Peck became known to Roy V. Wright, editor, *Railway Mechanical Engineer*, and past-president A.S.M.E., and in 1914 he left active railroading to become associate editor of the *Railway Age Gazette*, New York, N. Y., where he remained until 1919, when he was transferred to Chicago, Ill., as western mechanical editor, *Railway Age* and *Railway Mechanical Engineer*.

In 1923 Mr. Peck returned to New York as managing editor, *Railway Mechanical Engineer*, and mechanical-department editor of *Railway Age*.

Mr. Peck's association with the railways and the railway-supply industries drew him into the activities of railway clubs and associations and especially the work of the A.S.M.E. Railroad Division. From 1929 to 1934 he served on the executive committee of the division, and during this same five-year period he was a member of the A.S.M.E. Standing Committee on Professional Divisions.

During the closing year of his term he acted as chairman of the division, and, upon its expiration, he was appointed to the A.S.M.E. Committee on Publications. Although Mr. Peck's term on the Committee on Publications expired in 1940, President Hanley asked him to serve during the current administrative year to fill the unexpired term of a member who had resigned.

During Mr. Peck's chairmanship the Committee on Publications was faced with several important financial problems, in the handling of which his experience as managing editor of a technical magazine proved to be of great value. He submitted a noteworthy report to the Council in June, 1940, which covered the financial aspects of A.S.M.E. publications from 1929 to 1940 and afforded the Council the basis for important decisions relating to publications policy.

For the A.S.M.E. Metropolitan Section, Mr. Peck served as a member of the Program Committee in 1939-1940. He was then elected a member of the Executive Committee of the Metropolitan Section for a term of office which will expire in June, 1943.

W. H. Winterrowd

WILLIAM HOLLAND WINTERROWD, nominated for Vice-President of The American Society of Mechanical Engineers, was born on April 2, 1884, in the town of Hope, Ind. After finishing the grade and high schools in Shelbyville, Ind., he went to Purdue University from which he was graduated in 1907 with the degree of B.S. in M.E. In 1936 his alma mater honored him with a doctorate in engineering.

While in college, he spent his summers working as a locomotive wiper, blacksmith's helper, and repairman on various railroads. Upon graduation, he became a special apprentice with the L.S.&.M.S.R.R. (now the New York Central), and then engine-house foreman. In 1910 Dr. Winterrowd was made assistant to the mechanical engineer of the railroad. In 1912 he left to become mechanical engineer of the Canadian Pacific Railroad in Montreal, Canada.

In 1917, after converting part of the railroad's largest shop into a munitions plant, he was selected to accompany Sir George Bury, the executive vice-president of the railroad, to Russia, where Sir George served as a member of Lord Milner's mission to that country. There he had an opportunity to traverse a large proportion of the railways in European Russia and observe railway motive power, cars, shops, engine houses, as well as machine-tool equipment.

Upon his return to Montreal he was made chief mechanical officer of the Canadian Pacific Railway. Then, from 1923 to 1927, he was assistant to the president of the Lima Locomotive Works and from 1927 to 1934 was vice-president of that company. In 1934 he became vice-president of the Franklin Railway Supply Company, Inc., with offices in Chicago.

In 1939 he was appointed vice-president in charge of operations of the Baldwin Locomotive Works with headquarters at Eddystone, Pennsylvania.

Dr. Winterrowd joined the A.S.M.E. in 1907 as a junior member. He has been a member and chairman of the Committee on Publications, as well as of the Railroad Division and its Executive Committee; a member of Committee on Policies and Budget, Biographies, Junior Participation, and Citizenship Manual. He has served on the Executive Committees of both the Metropolitan and Chicago Sections. He is a manager of the Society and has been a member of its Executive Committee for the last two years.

Many technical articles and papers by Dr. Winterrowd on railway mechanical engineering have been published. He is a director of the Purdue Research Foundation, the Baldwin Locomotive Works, the Baldwin De La Vergne Sales Corporation, I. P. Morris and De La Vergne, Inc., the Baldwin-Southwark Corporation, and the Whitcomb Locomotive Company.

He is a member of the board of managers of The Franklin Institute of Philadelphia. He is also a member of the Canadian Railway Club, the Western Railway Club, the American Association of Railways, the Newcomen Society, as well as many other organizations.

W. R. Woolrich

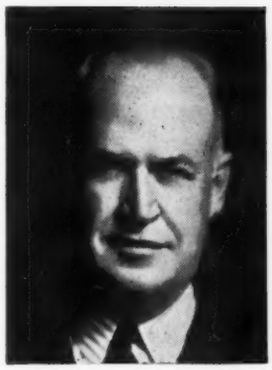
WILLIS RAYMOND WOOLRICH, nominated for Vice-President of The American Society of Mechanical Engineers, was born on March 1, 1889, in Mineral Point, Wis. While in high school and after, he had already launched his engineering career by working for the local electric company before school hours and later by performing duties from fireman to mill mechanic in a zinc-concentrating mill. However, shall we say, fortunately, the depression of 1907 closed the mill and the eighteen-year old boy was on his way to Madison, Wis., to take an engineering course at the University of Wisconsin. Dean Woolrich was granted a degree of B.S. in E.E. in 1911, but because most of his work in industry in later years was along the lines of mechanical engineering, it was most fitting that his alma mater should give him an M.E. degree in 1923.

Upon graduation, young Woolrich spent some time with the Commonwealth Edison Co. of Chicago and with the Union Switch and Signal Company of Swissvale, Pa. In 1911, he went back to Chicago to teach engineering at DePaul University, but after a year, left to take a training course with the Western Electric Company. After becoming assistant methods engineer, International Harvester Co. borrowed him so that he could institute a training course there similar to the one used at Western Electric. This course, which contained many of his own ideas, was so successful that he was invited to join the faculty of the University of Tennessee as an assistant professor of mechanical engineering.

After doing his bit during the World War, Dean Woolrich returned to the University where he eventually became head of his department. When the Tennessee Valley Authority was established in 1933, he was one of the first engineers selected to help develop this vast enterprise. In 1934, he was made a director and headed the agricultural-industries division until 1936 when he was called to the University of Texas to become dean of the college of engineering.

He is also director of the Bureau of Engineering Research of the University of Texas and during the present emergency is Adviser to the U. S. Department of Education on Engineering Defense Training for Region 18. He joined the A.S.M.E. in 1919, and served as secretary and then chairman of the Knoxville section. His abilities were soon recognized and as a result he was a member and later chairman of the Committee on Local Sections, and has been a member of the Nominating Committee, Special Research Committee on Mechanical Processing of Cottonseed, and the Process Industries Division. As chairman of the Committee on Local Sections, he was an advisory member of the Executive Committee of Council for two years. He was elected Manager of the Society in 1938 for a three-year term expiring in 1941.

Dean Woolrich has written many articles for technical magazines and several books, one of these being the Handbook of Refrigerating Engineering. He is a member of the A.S.R.E., S.P.E.E., Newcomen Society, Tau Beta Pi, Eta Kappa Nu, Phi Kappa Phi, Pi Tau Sigma, and Sigma Xi.



W. G. CHRISTY

H. L. EGGLESTON

T. S. MCEWAN

Nominated for Managers

William G. Christy

WILLIAM GASTON CHRISTY, nominated for the office of Manager of The American Society of Mechanical Engineers, is smoke-abatement engineer of Hudson County, New Jersey. He was born in Jerseyville, Ill., on Oct. 27, 1886, and was graduated from Cornell University in 1911 with the degree of mechanical engineer.

For a year after graduation, Mr. Christy worked as an engineer for the Heine Boiler Co. From 1912 to 1915, he was an assistant to H. H. Humphrey, consulting engineer of St. Louis, specializing in power plants, heating, and ventilating. In 1915, Mr. Christy organized and managed his own company which acted as a manufacturers' agent for heating and power-plant equipment and specialties. When the United States entered the World War in 1917, he became production engineer for the Emergency Fleet Corporation, St. Louis District, expediting equipment ordered on contracts and making surveys of manufacturing plants for the government. In 1918 he was appointed district supply manager for the Corporation.

As superintendent and field engineer of the St. Louis Boat & Engineering Co. in 1920, Mr. Christy was in charge of construction of four large steel towboats built for use on the Mississippi River by the U. S. Engineer Department. From 1923 to 1925, he was vice-president and general manager of Schubert-Christy Construction & Machinery Co., St. Louis, Mo.

Mr. Christy began his smoke-abatement work in 1926 when he helped to organize and became the executive secretary of the Citizens Smoke Abatement League of St. Louis, which undertook one of the most comprehensive smoke-control campaigns in the United States. As a result of his work in St. Louis, he was requested in 1930 to organize and head as smoke-abatement engineer the Hudson County Department of Smoke Regulation in the State of New Jersey. This department, in cooperation with railroad, marine, and industrial companies, has been more than 90 per cent successful in its smoke-elimination program. In addition to the duties of his present position, Mr. Christy has done considerable consulting work in smoke-dust-cinder abatement for several plants and cities in the East and Middle West.

Since joining the A.S.M.E. in 1919, he has been very active in local sections, professional divisions, and national committees of the Society. His activities include the chairmanship of the St. Louis Section, 1925; delegate to Local Sections Conferences, 1924 and 1925; secretary of Fuels Division, 1928, 1933 to 1936; chairman of Fuels Division, 1941; and member of Power Test Code Committee on Dust Separating Apparatus. Other technical organizations in which he holds membership include the National Association of Power Engineers, New Jersey Society of Professional Engineers, Smoke Prevention Association, and Cornell Society of Engineers. He is also active in civic affairs, being president of the Jersey City Rotary Club, 1940–1941, director of the Jersey City Community Welfare Fund, 1936 to date, and vice-president of the Jersey City Boys' Club, 1936 to date.

He has written numerous technical articles on combustion, smoke abatement, and fuel conservation, some of which have been published in A.S.M.E. Transactions and in MECHANICAL ENGINEERING. As an authority in the field of smoke abatement, Mr. Christy has appeared as a speaker and expert before civic groups, chambers of commerce, trade associations, professional and technical societies, city governing bodies, and other groups.

Herbert L. Eggleston

HERBERT LYMAN EGGLESTON, candidate for the office of Manager of The American Society of Mechanical Engineers, is chairman of the Society's Standing Committee on Local Sections, and manager of the gas and refining departments, Gilmore Oil Company, Los Angeles, Calif. Born on March 18, 1892, in Olean, N. Y., he was educated in the grade schools of Olean, N. Y., and Bayonne, N. J., except for a two-year period spent in the schools of Bucharest, Rumania. After completing courses at Bayonne High School and Phillips Andover Academy, he attended the Sheffield Scientific School, Yale University.

His first position was at the El Segundo refinery of the Standard Oil Co. of California. After seeing service with the A.E.F. in France, he returned to the El Segundo refinery. From 1920 to 1928, he was associated with the Pan American Petroleum Co. of California as absorption plant operator, superintendent of gas plants, and manager of the gas department. Since 1928, he has held his present position with the Gilmore Oil Company.

Mr. Eggleston has been very active in local and national affairs of the A.S.M.E. since he joined it in 1928. He was elected member of the executive committee of Los Angeles Section in 1935 and chairman in 1936. In 1936, he represented his Section at the Local Sections Conference at Seattle and, in 1938, was secretary of the General Committee for the National Spring Meeting of the A.S.M.E. in Los Angeles. His appointment to the Committee on Local Sections in 1936 enabled him to expand his activities in behalf of Sections. He became chairman of the committee in December, 1940.

He helped to organize and became a charter member in 1926 of the California Natural Gasoline Association. Mr. Eggleston has served as member of the Association's executive committee since 1926, as vice-president in 1928, 1929, and 1933, and as president in 1934. Other technical organizations in which he holds membership include the Society of Automotive Engineers, the American Society of Heating and Ventilating Engineers, and the Yale Engineering Association.

Thomas S. McEwan

THOMAS SPRING McEWAN, consulting management engineer of Chicago, Ill., who has been nominated for the office of Manager of The American Society of Mechanical Engineers, was born on April 1, 1889, in Jersey City, N. J. After the usual education in grade and high schools, he entered Cornell University from which he was graduated in 1911 with the degree of mechanical engineer.

His first position was as an engineer in the West Lynn, Mass., plant of the General Electric Co. In 1915 he became assistant sales manager of the SKF Manufacturing Co., being stationed in New York, N. Y., and Hartford, Conn. When the United States declared war in 1917, he saw service as a Second Lieu-

tenant in the Aviation Section, S.R.C., U. S. Army. Upon his discharge from the Army, he accepted a position as Chicago district sales manager with the Cowan Truck Division, Yale & Towne Manufacturing Co.

In 1925 Mr. McEwan joined the Haynes Corporation, Chicago, Ill., as a consulting management engineer and senior vice-president. In 1933, he became connected with Stevenson, Jordan & Harrison, New York and Chicago, in a consulting management and engineering position. His work throughout the Middle West covered all phases of management and engineering. Until 1940, he continued this type of work with McClure, Hadden & Ortman, Chicago, Ill.

Because of his extensive knowledge of the facilities, equipment, and personnel possessed by plants throughout the Chicago area, Mr. McEwan late in 1940 was selected to head the defense contract service of the Office of Production Management in Chicago as district manager.

He has been a member of the A.S.M.E. since 1915. Despite the many duties in connection with his work, Mr. McEwan has found time to take part in the activities of the Chicago Section, serving as chairman for three years, 1936–1938. At present, he is president of the Cornell University Club of Chicago.

Bureau of Labor Statistics Issues Report on Engineering Employment and Earnings, 1929 to 1934

MEMBERS of The American Society of Mechanical Engineers will recall the series of seven reports on employment and earnings in the engineering profession, 1929 to 1934, that appeared in MECHANICAL ENGINEERING from August, 1936, to December, 1937. These reports were based on a questionnaire relating to professional experience and status, prepared by the United States Bureau of Labor Statistics, Dr. Isador Lubin, Commissioner, at the request and with the cooperation of the American Engineering Council. Questionnaires were mailed to 173,151 persons, representative of every phase of engineering activity, and the net number of usable returns was 52,589. Of these there were 33,841 returns from older engineers who reported that they were professionally active prior to 1930. The remaining 18,748 returns included younger engineers who had entered the profession in the period 1930–1934. The 33,841 returns averaged 15 per cent of the 226,136 technical engineers reported in the 1930 census.

Summary reports of the results of the Bureau of Labor Statistics study of the returns were published in the *Monthly Labor Review*, and abstracted in MECHANICAL ENGINEERING. They covered "Education of the Engineer," "Unemployment of the Engineer," "Employment of the Engineer," "Security in Engineering Employment," "Earnings of Engineers," "Annual Incomes of Engineers," and "Monthly Earnings of Engineers."

The complete report of the study is now available in Bulletin No. 682, United States Department of Labor, Bureau of Labor Statistics, "Employment and Earnings in the Engineering Profession 1929 to 1934," by Andrew Fraser, under the direction of A. F. Hinrichs, assistant commissioner. In addition to the summary reports abstracted in MECHANICAL ENGINEERING and named in the preceding paragraph, Bulletin No. 682 contains a summary, a chapter on scope and method, a chapter on "limitations of the data for prediction purposes," and numerous appendixes.

In a preface to the Bulletin, signed by Commissioner Lubin, are these "high lights:"

1 The number of engineers increased by more than 25 per cent between 1929 and 1934. The number of engineering jobs increased by less than 5 per cent.

2 In both 1932 and 1934 substantial numbers of engineers were unemployed. In the worst period approximately one tenth were unemployed at the same time.

3 A far larger proportion, about one third of the total number, experienced unemployment at one time or another from 1929 to 1934.

4 Under these conditions entry into the profession was unusually difficult. Large numbers of graduates of 1930–1934 classes were unemployed for considerable periods. Many were forced into nonengineering employments and entrance salary rates were severely depressed.

5 Despite this fact, three fifths of the graduates of 1930–1934 did have engineering jobs at the close of 1934.

6 Older engineers were less likely than younger engineers to lose their jobs. When they did so, however, the older engineers had a more difficult time in getting themselves rehired.

7 The small increase in the total number of engineering jobs between 1929 and 1934 is entirely due to an increase in public employment. Employment with private firms declined 8.2 per cent.

8 The average annual earnings of all engineers declined from $3412 in 1929 to $2286 in 1934, a decline of one third. This reflects lower rates, loss of employment, and poorer types of employment.

9 The average rates paid for all engineering services declined from $289 per month to $210, a decrease of 27.3 per cent.

10 At any time there is a wide range in the annual earnings of engineers. Thus, in 1929, 10 per cent earned less than $1878 while the highest 10 per cent earned more than $7466.

11 The average earnings of engineers increased with age up to the group 60 to 65 years of age. The initial increases are relatively rapid.

12 The earnings of the lowest 10 per cent of the engineers of comparable age do not advance significantly after 40 years of age, and are little if any higher than the usual average earnings of groups 3 or 4 years after graduation.

13 While differences in earnings among the various classes of engineering are quite pronounced, the striking characteristic of entrance rates into the profession is their similarity as between different classes of engineers and as between different types of work.

Civil Service Commission Announces Urgent Demand for Personnel

THE personnel needs of the national-defense program are many and varied and the United States Civil Service Commission is making every effort to meet the demand to fill all types of jobs.

Following are announcements of positions available that have been received during the last month:

High-Grade Executives

Of particular interest to persons experienced in management of important private or public enterprises are five grades of administrative positions, mostly in national-defense agencies, as follows: Executive officer, $8000; chief administrative officer, $6500; principal administrative officer, $5600; senior administrative officer, $4600; and administrative officer, $3800 a year. Positions at these levels are the very highest ordinarily filled through civil service. The standard of requirements is correspondingly high.

No written examination is required but to be eligible a person must show experience, acquired either in public or private employment, involving important and extensive administrative responsibility, or broad experience as a successful consultant or adviser in public or business administration, scientific or industrial management.

Form 4000-ABC with information concerning the detailed requirements is the one to be requested.

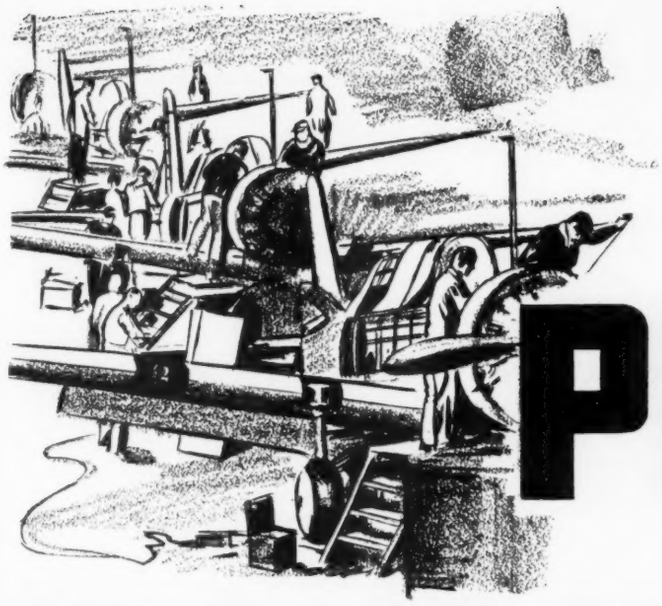
Naval Architects and Marine Engineers Still Sought

Revised examinations are announced for persons qualified in all branches of naval architecture and marine engineering. Persons are particularly needed for filling positions in the assistant and associate grades ($2600 and $3200 a year, respectively). However, naval architects or marine engineers qualified to fill all the grades (salaries range as high as $5600 a year) are urged to apply at once, although applications will be accepted until June 30, 1942. The experience and education requirements have been modified.

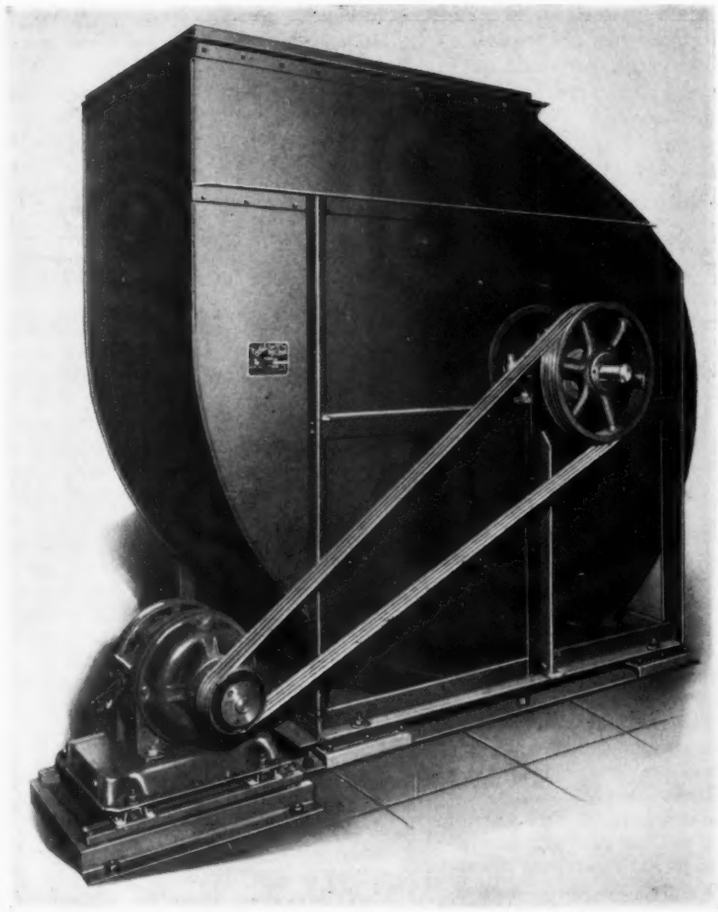
Plant-Inspection Positions

Announcement is made of open competitive examinations for plant-inspection positions paying from $2900 to $4600 a year.

(*A.S.M.E. News continued on page 630*)



FAN POWER TO BACK MAN POWER



● Today's exacting production schedules call for *human* efficiency—every working hour of the day. And that makes proper working conditions imperative! Fresh, clean air is the first step. Buffalo "Limit-Load" Fans provide industry with ventilation that can be depended on. These fans are built to stay put—with minimum attention and low power costs. What's more, the practical design and structural balance of Buffalo "Limit-Load" Fans means truly *quiet* ventilation. Better write today for complete engineering data on the Buffalo line of fans for every ventilating requirement.

BUFFALO FORGE COMPANY

148 Mortimer Street, Buffalo, New York

Branch Engineering Offices in Principal Cities

Canadian Blower & Forge Co., Ltd.,
Kitchener, Ont.

"Buffalo" **FANS**

for VENTILATION • EXHAUSTING • HEATING • COOLING
FORCED DRAFT • AIR CONDITIONING

Persons may be eligible to apply who have had full-time responsible experience as fire marshall or inspector of a large city fire department, investigator of large industrial installations for a fire or indemnity insurance company, safety director in a large commercial establishment, technical safety engineer or consultant, or as plant engineer with responsibility for a plant-wide safety program.

Naval Ordnance Inspectors Needed

Open continuous examination is announced for inspectors of naval ordnance materials, at salaries ranging from $1620 to $2600 a year. Hundreds of inspectors are needed by the Bureau of Ordnance of the Navy Department for interpreting Navy specifications and checking compliance with them of materials to be delivered to the Navy by defense contractors. No written examination is given but applicants are rated on the basis of education, training, and experience as shown on applications.

How to Obtain Applications

Applications and further details on the foregoing positions may be obtained from the U. S. Civil Service Commission in Washington, D. C., from any of the Commission's district offices, or at any first-class post office.

A.I.E.E. Elects Officers

THE American Institute of Electrical Engineers announces election of officers for the year beginning August 1, 1941, as follows: president, David C. Prince; vice-presidents, N. S. Hibsham, J. Elmer Houseley, Arthur L. Jones, Walter C. Smith, and C. A. Price; directors, Lester R. Gamble, T. G. LeClair, and Fred R. Maxwell, Jr.; treasurer, W. I. Slichter.

Men and Positions Available

Send Inquiries to New York Office of Engineering Societies Personnel Service, Inc. This service is operated on a cooperative, nonprofit basis, whereby those actually placed in positions by the Service agree to contribute to help maintain this service

29 W. 39th St.	211 West Wacker Drive	57 Post Street	Hotel Statler
New York, N. Y.	Chicago, Ill.	San Francisco, Calif.	Detroit, Mich.

MEN AVAILABLE[1]

MECHANICAL ENGINEER, Stevens Institute, 1924; 38; New York license; 15 years' domestic and foreign experience in construction management and design concrete and masonry, boiler, chemical, industrial-plant accessories; seeks broader field. Employed. Me-664.

CHIEF DESIGNER OR PLANT ENGINEER, 44; experience in plant layout, development, design, construction, installation and maintenance of machine tools, hydraulic equipment, special processing machinery, power plants, powerhouses. Me-665.

MECHANICAL ENGINEER, B.S.M.E., 30. Five years of electrical and mechanical development and supervision of radio and electromechanical instruments and gages. Also purchasing and cost-estimating experience. Married, reliable, and ambitious. Me-666.

MECHANICAL ENGINEER, B.S.M.E.; 11 years' experience in design, research, maintenance, lubrication, and power-plant engineering. Capable directing engineering, purchasing, and construction in this type of work. Me-667.

MECHANICAL ENGINEER, Columbia, A.B. M.E.; New England family; 58, single, 25 years' experience, mainly work in power stations, personnel administration, writing; licensed professional engineer; now available for permanent work. Me-668.

MECHANICAL ENGINEER, 22; approximately one year's experience in production work, considerable shop experience, industrial-engineering major while at school; desires position in industrial-engineering department of progressive company. Me-669.

ASSISTANT PROFESSOR of mechanical engineering, 28, married. Four years' experience teaching engineering mechanics; 3 years' industrial experience in machine design and production methods; Tau Beta Pi; desires position as assistant professor. Me-670.

COORDINATOR, PLANNER, 43; maintenance and development of heavy mechanical or marine equipment, piping specialist; very practical but with good technical background; available to any location on short notice. Me-671.

MECHANICAL ENGINEER, 47; 25 years' varied experience in mechanical, civil, and electrical engineering in research and developmental work; desires connection along the same lines. Available immediately. Me-672.

MANUFACTURING EXECUTIVE, M.E., 31. Eight years' experience, methods, development plant layout, tool design, operation planning, production supervision, equipment investigation and purchase, cost estimating, production planning, personnel problems, successful record. Now employed. Me-673.

GRADUATE ENGINEER, 39. Fifteen years of electromechanical machine design, industrial-plant layout, design and supervision of construction of production equipment, heating, ventilating, refrigerating, air conditioning, electric power. Metropolitan New York preferred. Me-674.

[1] All men listed hold some form of A.S.M.E. membership.

POSITIONS AVAILABLE

DESIGN ENGINEER, 30–40, proficient in concrete, timber, and steel design with outstanding mathematical ability, capable of taking care of a small drafting room. Excellent opportunity. Permanent. Salary about $4000 a year to start. New England. Y-8393.

EQUIPMENT AND TOOL ENGINEER to act as assistant to works engineer of a large metal-processing manufacturer. Would be entirely responsible for tooling and equipment. Salary, $6500–$7500 a year. New England. Y-8412.

INDUSTRIAL ENGINEER, not over 45, preferably one with some experience in woodworking plants to act as representative of firm of consulting engineers. Must know organization and production planning, time study, wage incentives, methods, and processes. Position permanent. Salary, $4000 to $4500 a year. Middle West. Y-8422C-D.

CHIEF ENGINEER, 37 to 45, to act as assistant to vice-president in charge of production of large process industry. Should have thorough knowledge of machinery similar to paper and pulp equipment such as dehydrators, breaker beaters, driers, mills, etc. Should also have knowledge of design of equipment, plant layout from viewpoint of labor and cost, and be capable of directing power-plant operation and efficient use of steam in the manufacturing process. Salary, about $7500 year. Position permanent. Location, New Jersey. Y-8424.

SENIOR PIPING ENGINEERS familiar with design and layout of high-pressure, high-temperature piping for power plants and oil refineries. Will lay out piping, check stresses, and do detailing for fabrication. Knowledge of structural piping supports carried by building structure would be beneficial. Salary, $3300 a year for 40-hour week, with time and a half for overtime. East. Y-8433-R-120-C.

MECHANICAL ENGINEER thoroughly familiar with manufacturing processes of small parts, including thorough acquaintance with manufacturing materials, with the availability of various forming processes, such as die casting, powder metallurgy, etc., with possibility of various methods of machining. Salary open. Location, New York metropolitan area. Y-8434.

MARKET ANALYST, 30–35, preferably graduate mechanical engineer. Must be capable of making preproduction field surveys and presenting findings in an understandable form. Will be required to analyze dealer and distribution contracts from engineering viewpoint, and will deal with executives and workers. Applicant must have sound industrial background. Salary, from $5000 a year. Permanent. East. Y-8441.

MECHANICAL ENGINEER as estimator and detailer for metal manufacturer. Would be required to figure costs of machine-shop work from blueprints. Salary, $3600–$4200 a year. New York metropolitan area. Y-8449.

WORKS MANAGER, 35–50, for metals-trade plant employed in drop-forge and machine-shop operations. Applicant should have thorough knowledge of heat-treating, hardening, tooling, and machine-tool operation; should also be able to supervise methods, cost, and production control; as plant manufactures for stock, an understanding of inventory is essential. Salary, about $5000 a year. New England. Y-8450.

(*A.S.M.E. News continued on page 632*)

With reputations depending on performance, Diesel engine builders take no chances in selecting materials. Hence the widespread use of Molybdenum irons for such vital parts as cylinder heads, liners and pistons where heat resistance, as well as strength and wearing quality, is demanded.

Molybdenum in combination with chromium makes gray iron highly resistant to growth and cracking, gives good wear resistance and strength—all at comparatively low cost.

Write for our free technical book "Molybdenum in Cast Iron" for detailed, helpful data.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
MOLYBDIC OXIDE BRIQUETTES FOR THE CUPOLA—FERROMOLYBDENUM FOR THE LADLE

Climax Molybdenum Company
500 Fifth Avenue · New York City

MOLY

INDUSTRIAL ENGINEER thoroughly acquainted with operations and production output of machines used in small precision-parts manufacturing field. Applicant will be in full charge of new machine layout. Must be acquainted with material receiving, stock storage, industrial transportation, etc. Must be U. S. citizen. Duration, one year. Salary open. New York, N. Y. Y-8459.

MECHANICAL ENGINEER for design and development of instruments. Should have sound knowledge of tooling and small precision-parts manufacture. A knowledge of optics would be helpful. Must be of research turn of mind and capable of meeting and solving complex problems. Must have initiative and personality. Salary open. New York, N. Y. Y-8470.

MECHANICAL ENGINEER experienced in development and design of automotive and motorcycle engines. Any knowledge of design of motorcycle and air-cooled engines would be helpful. Must possess qualities of originality, thoroughness, and accuracy. Also require mechanical-design draftsmen experienced in one or all of the following fields: automotive, motorcycle, gas engine, and machine design. Salaries open. Ohio. Y-8476-D.

SPECIALISTS acquainted with processes, marketing methods, prices, etc., of particular industries to meet leaders in these industries and discuss the problems of the industry. Men required in (*a*) petroleum (East); (*b*) nonferrous metals; (*c*) ferrous metals; (*d*) furniture; (*e*) coal; (*f*) textiles. Salary, $3200–$5600 a year. Duration, one year. East. Y-8490.

DESIGNER, mechanical engineer with minimum of five years' experience as designer and project engineer on gearing and electric-motor-driven precision machinery. Salary, $2600–$4000 a year. New York metropolitan area. Y-8503.

COMPTROLLER. Must be well acquainted with machine-tool industry or heavy durable goods manufacture. Must have wide knowledge of costs, general accounting, and budgetary control of all operations. Salary, $6000–$10,000 a year. New England. Y-8528.

PERSONNEL AND EMPLOYMENT MANAGER with some knowledge of machine-shop practice to handle employment, welfare, safety, foreman training, etc., for manufacturing company. Salary open. New England. Y-8529.

TIME-STUDY ENGINEER, 35–50, to install system in woolen mill or textile mill. Previous experience in this line desirable. Location, East. Y-8534.

MECHANICAL ENGINEER for laboratory. Will work under chief engineer conducting laboratory tests as well as designing laboratory equipment. Duties will consist of designing, building, and conducting tests on both new and old equipment. Company is investigating field of fluid mixing with purpose of establishing the fundamental more accurately and designing new machines for higher ranges of viscosity. East. Y-8538.

INDUSTRIAL ENGINEER with some experience in metalworking industries such as hardware manufacture, etc. Man with sufficient contact with plating and polishing departments to have good working knowledge of technical aspects of these operations. Salary open. New England. Y-8545.

DESIGNERS, not over 40, with experience on high-class machine-tool design, for development work in the abrasive field. Salary, $4500 a year. Permanent. Pennsylvania. Y-8549.

FACTORY SUPERINTENDENT for small plant. Some experience in the machining of hard woods; one who knows tool and die work. Salary, $3000 a year. Location, New York metropolitan area. Y-8553.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after August 25, 1941, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and transfer to Member

NEW APPLICATIONS

For Member, Associate, or Junior

ASHTON, THOMAS P., Waterbury, Conn. (Rt)
BOALS, R. B., Eugene, Oregon (Rt)
BOLAND, L. C., JR., Atlanta, Ga.
BRUCE, IRVING W., Albany, Calif.
CRANLEY, THOMAS E., Cincinnati, Ohio
DAVIDOFF, MORRIS, Miami Beach, Fla.
DONAHUE, EDW. B., Honolulu, T. H.
FOGARTY, JOHN E., Mt. Vernon, Ill.
FRIEDMAN, VICTOR, New York, N. Y.
GEHRES, HEWITT A., Mt. Vernon, Ohio
GREGORY, WM. K., Louisville, Ky. (Rt)
HAYES, ELMER H., Belmont, Mass.
HOOPER, IRVIN P., Terre Haute, Ind. (Re)
HUDSON, FREEMAN B., JR., Jersey City, N. J.
LESTER, BERNARD, New York, N. Y.
LINDSTROM, DONALD F., Atlanta, Ga.
LINGNER, GEO. L., Woodcliff, N. J.
LOBISSER, RAYMOND J., Norwood, Mass.
LOWRY, PAUL M., St. Joseph, Mo.
MILLER, HARRY, Waterbury, Conn.
MILLS, MICHAEL, Upper Darby, Pa.
MINER, IRVING O., Rumford, R. I.
PAREKH, G. D., Benares City, India
PERKINSON, THOMAS F., Erie, Pa.
RODIN, MAX B., South Bend, Ind. (Rt)
SAXTON, EDMOND F., Brooklyn, N. Y.
SHEETS, HERMAN E., East Moline, Ill.
SIKORSKY, IGOR I., Bridgeport, Conn.
SIMONS, MORRIS, New York, N. Y.
TROLLER, THEO. H., Akron, Ohio
WARD, JOHN H., St. Joseph, Mo.
WANAMAKER, GEORGE K., JR., Cincinnati, Ohio
WEIL, RICHARD L., New York, N. Y.
ZAHN, OTTO E. E., Mishawaka, Ind.
ZIMMERMAN, ALBERT, Tiburon, Calif.

CHANGE OF GRADING

Transfers to Member

BRAGG, DAVID K., Foxboro, Mass.
CHILDS, E. WALLACE, JR., New Britain, Conn.
GRAF, FREDK. J., Wellesley Hills, Mass.
HAUSMAN, SIDNEY, Cedarhurst, Md.
HIRSCH, BERTRAM H., Washington, D. C.
MARX, ERICH, San Francisco, Calif.
O'NEIL, CHAS. H., Fall River, Mass.
SCHWEIKART, HERBERT C., Reading, Pa.
STRUTZ, CLARENCE R., Chicago, Ill.
WHIPPLE, THOMAS T., Bronxville, N. Y.

Necrology

THE deaths of the following members have recently been reported to the Society:

BAKER, CHARLES WHITING, June 5, 1941
BULLARD, DUDLEY B., June 10, 1941
HARRISON, GEORGE G., June 4, 1941
MUHLFELD, JOHN E., June 19, 1941
POTBURY, ALFRED H., May 30, 1941
RUPARD, HOMER, June 20, 1941

A.S.M.E. Transactions for July, 1941

THE July, 1941, issue of the Transactions of the A.S.M.E. contains:

Turbine Discharge Metering at the Safe Harbor Hydroelectric Development, by J. M. Mousson
Speed Regulation of Kaplan Turbines, by J. D. Scoville
Development of the Automatic Adjustable-Blade-Type Propeller Turbine, by R. V. Terry
Production of Seamless Tubes by Combined Effects of Cross-Rolling and Guide Disks, by W. Trinks
The Flow of Saturated Water Through Throttling Orifices, by M. W. Benjamin and J. G. Miller
Train Acceleration With Steam Locomotives, by L. B. Jones
Discharge Coefficients of Long-Radius Flow Nozzles When Used With Pipe-Wall Pressure Taps, by H. S. Bean, S. R. Beitler, and R. E. Sprenkle
Remarks on the Analogy Between Heat Transfer and Momentum Transfer, by L. M. K. Boelter, R. C. Martinelli, and Finn Jonassen
Effect of Ambient Temperatures on the Coefficients of Venturi Meters, by W. S. Pardoe